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STRESS ANALYSIS OF THE EXTERNAL STORES DP EJECTION LAUNCHER/INN--ETC(U)
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NWC Technical Memorandum 3358

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STRESS ANALYSIS OF THE EXTERNAL STORES DP EJECTION LAUNCHER/ INNER TUBE SUBSYSTEM.

by

Anthony L. Freeman
Earl R. Hanblem
Gale W. Paxton
Engineering Division
COMARCO INC.

for the
Propulsion Systems Division
Ordnance Systems Department

Nov[redacted]78

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The contents of this report are the results of a stress analysis conducted on the critical areas of the DP Ejection Launcher Inner Tube Subsystem. It was determined that the hardware and/or assemblies experiencing the critical load conditions were the tube, power cylinder assembly, detent assembly, warm cable cutter assembly, plumbing fittings and tubing. The stress analyses on these components and subsystems are presented on the following pages in the form of mathematical calculations and accompanying sketches without explanatory text. The drawings in Figures 1-5 (pages 50-54) show how the components relate to the overall system and give more detail on the items tested.

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17. GIDEP REPRESENTATIVE M. H. Sloan	18. PARTICIPANT ACTIVITY AND CODE Naval Weapons Center, China Lake, CA (X7)

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INTRODUCTION

The contents of this report are the results of a stress analysis conducted on the critical areas of the DP Ejection Launcher Inner Tube Subsystem. It was determined that the hardware and/or assemblies experiencing the critical load conditions were the tube, power cylinder assembly, detent assembly, warm cable cutter assembly, plumbing fittings and tubing. The stress analyses on these components and subsystems are presented on the following pages in the form of mathematical calculations and accompanying sketches without explanatory text. The drawings in Figures 1-5 (pages 50-54) show how the components relate to the overall system and give more detail on the items tested.

Equations and other data used in this analysis were obtained from the *Machinery's Handbook*[1] and *Formulas for Stress and Strain.*[2]

The materials used throughout this analysis are 304, 316, and 17-4Ph corrosion resistant steel, AMS5700 series steel, and 6061-T6 aluminum alloy. The mechanical properties for all material used in this analysis are shown in Table 8.1, page 46. In all cases the lowest specified values were used to insure a conservative design.

Each area has been analyzed for worst case under the following conditions:

Maximum Internal Pressure (P_x)	5,000 psi
Internal Operating Pressure (P_y)	2,000 psi
Maximum External Pressure (P_z)	700 psi
Maximum Handling Load (P_H)	25,000 lb

Where worst case load conditions differ from those listed above, they are so noted at the specific point of analysis.

The final result is the safety factor (SF) achieved or in some cases, deflection. These values are listed in the Summary Table 8.2, page 47.

---

[1] *Machinery's Handbook*, 20th ed. New York, Industrial Press, Inc., 1976.

[2] Raymond J. Roark. *Formulas for Stress and Strain*, 3rd ed. New York, McGraw-Hill, 1971.

ABBREVIATIONS AND SYMBOLS

A	area (in^2)
Al	aluminum
ALY	alloy
B_A	bearing area (in^2)
B_L	maximum bearing load (lbs)
B_S	bearing stress (psi)
CRES	corrosion resistant steel
D	outside diameter (in.)
d	inside diameter (in.)
E	modulus of elasticity (psi)
I	moment of inertia
IN.	inches
ℓ	moment arm (in.)
LBS	pounds
M	moment (in.lbs)
m	I/V
n	number of threads
P	external collapsing pressure (psi)
P'_D	pitch diameter (in.)
P_E	ejection load (lbs)
P_H	handling load (lbs)
P_x	maximum internal pressure (psi)
P_Y	internal operating pressure (psi)
P_Z	maximum external pressure (psi)
p	thread pitch
PSI	pounds per square inch (lbs/in^2)
R	radius (in.)
S_A	shear area (in.)
S_B	maximum bending stress (psi)
S_L	shear load (lbs)
S_S	shear stress (psi)

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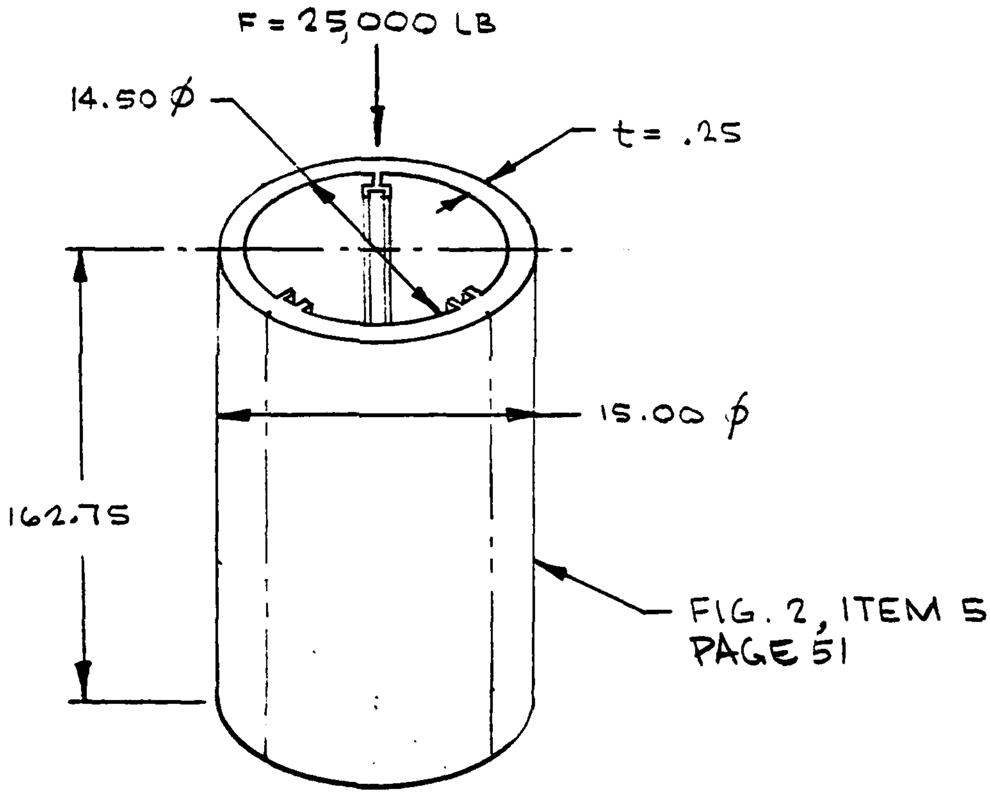
S_2	hoop membrane stress (psi)
SF	safety factor
T_A	tensile area (in.^{2})
T_L	maximum tensile load (lbs)
T_S	tensile stress (psi)
t	thickness (in.)
v	Poisson's ratio
y	deflection (in.)
Z	section modulus
σ_s	shear strength (psi)
σ_{ULT}	ultimate tensile strength (psi)
σ_{ULTB}	ultimate bearing strength (psi)
σ_y	yield strength (psi)
σ_{yB}	bearing yield strength (psi)
ϕ	diameter

1.0 TUBE

MATERIAL: SEE TABLE 8.1, ITEM 5, PAGE 6

SOLVING FOR SF



COLUMN LOAD

$$\frac{P_H}{A} = \frac{25{,}000}{\frac{\pi}{4}\left[(15)^2-(14.5)^2\right]} = \frac{25{,}000}{11.585} = \underline{2158\ \text{LBS/IN}^2}$$

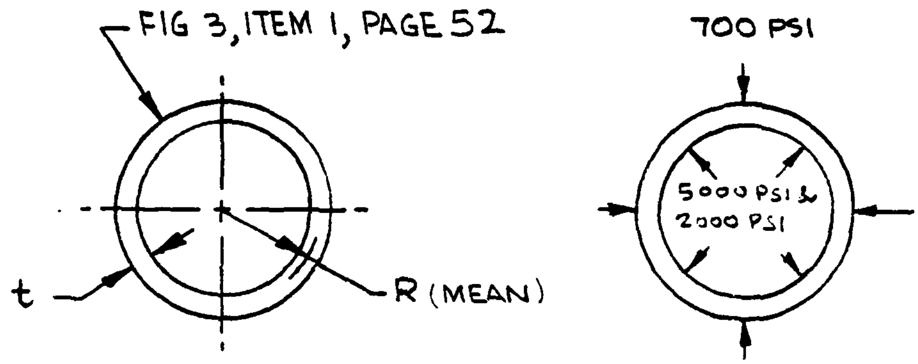
$$SF = \frac{35{,}000}{2158} = \underline{\underline{16.22}}$$

2.0 POWER CYLINDER

2.1 CYLINDER WALL

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46.

SOLVING FOR SF



STRESS FROM INTERNAL PRESSURES

S_2 @ P_x & σ_{ULT} $\therefore$ $S_2 = \dfrac{P_x R_{(MEAN)}}{t}$

WHERE: P_x = 5,000 PSI, $R_{(MEAN)}$ = 1.09375 IN., t = .1875 IN.

THEN $S_2 = \dfrac{(5000)(1.09375)}{.1875}$

$S_2 = \underline{29,167 \text{ PSI}}$ ◀—

EXISTING SF $= \dfrac{\sigma_{ULT}}{S_2}$

$= \dfrac{80,000 \text{ PSI}}{29,167 \text{ PSI}}$

SF = $\underline{\underline{2.74}}$ ◀—

S_2 @ P_Y & σ_y $\therefore$ $S_2 = \dfrac{P_y R_{MEAN}}{t}$

WHERE: P_y = 2,000 PSI, R_{MEAN} = 1.09375 IN., t = .1875 IN.

THEN $S_2 = \dfrac{(2000)(1.09375)}{.1875}$

$S_2 = \underline{11,667 \text{ PSI}} \leftarrow$

EXISTING $SF = \dfrac{\sigma_y}{S_2}$

$= \dfrac{30,000 \text{ PSI}}{11,667 \text{ PSI}}$

$SF = \underline{\underline{2.57}} \leftarrow$

STRESS FROM EXTERNAL PRESSURE

$$P' = \frac{t}{R}\left[\frac{\sigma_y}{1+4\left(\frac{\sigma_y}{E}\right)\left(\frac{R}{t}\right)^2}\right]$$

$$P' = \frac{.1875}{1.09375}\left[\frac{30\times10^3}{1+4\left(\frac{30\times10^3}{28\times10^6}\right)\left(\frac{1.09375}{.1875}\right)^2}\right]$$

$$P' = (.1714)\left[\frac{30\times10^3}{1+(4.2857\times10^{-3})(34.028)}\right]$$

$$P' = (.1714)\left[\frac{30\times10^3}{1.1458}\right]$$

$P' = \underline{4488 \text{ PSI}} \leftarrow$

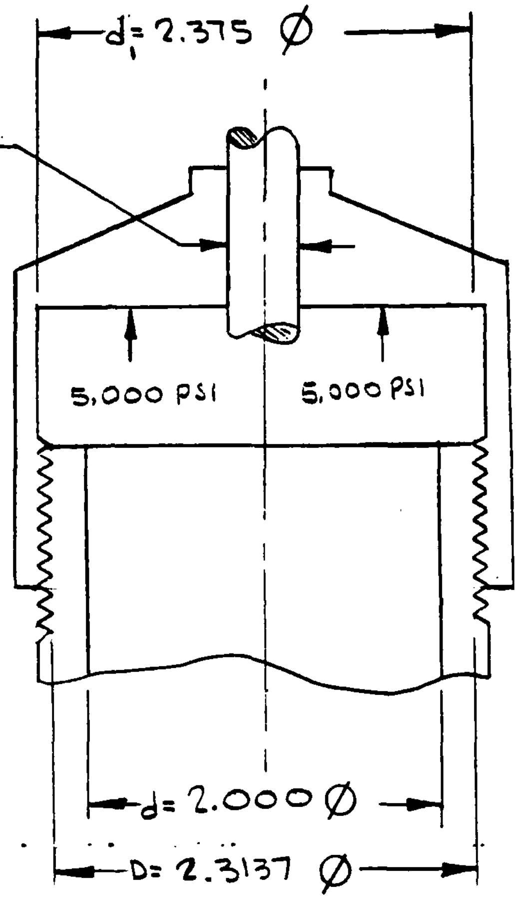
EXISTING $SF = \dfrac{P'}{P_Z}$

$= \dfrac{4488 \text{ PSI}}{700 \text{ PSI}}$

$SF = \underline{\underline{6.41}} \leftarrow$

CYLINDER WALL, THREADED END

SOLVING FOR SF



TENSILE LOAD ON
THREADED PORTION
OF CYLINDER WALL

$$T_L = P \times A\ ;\ A = \frac{\pi}{4} d^2 = (.7854)(2.375)^2 = (.7854)(5.6406) = 4.4301\ IN^2$$

$$\therefore\ T_L = (5000)(4.4301)$$

$$T_L = \underline{22{,}151\ LB} \leftarrow$$

$$T_A = \frac{\pi}{4}\left[D^2 - d^2\right] = (.7854)\left[(2.3137)^2 - (2)^2\right]$$

$$= (.7854)\left[(5.3532) - (4)\right]$$

$$T_A = \underline{1.0623\ IN^2} \leftarrow$$

$$T_s = \frac{T_A}{T_L} = \frac{22151}{1.0628}$$

$$T_s = \underline{20{,}842 \text{ PSI}}$$

$$\text{EXISTING } SF = \frac{\sigma_{ULT}}{T_s}$$

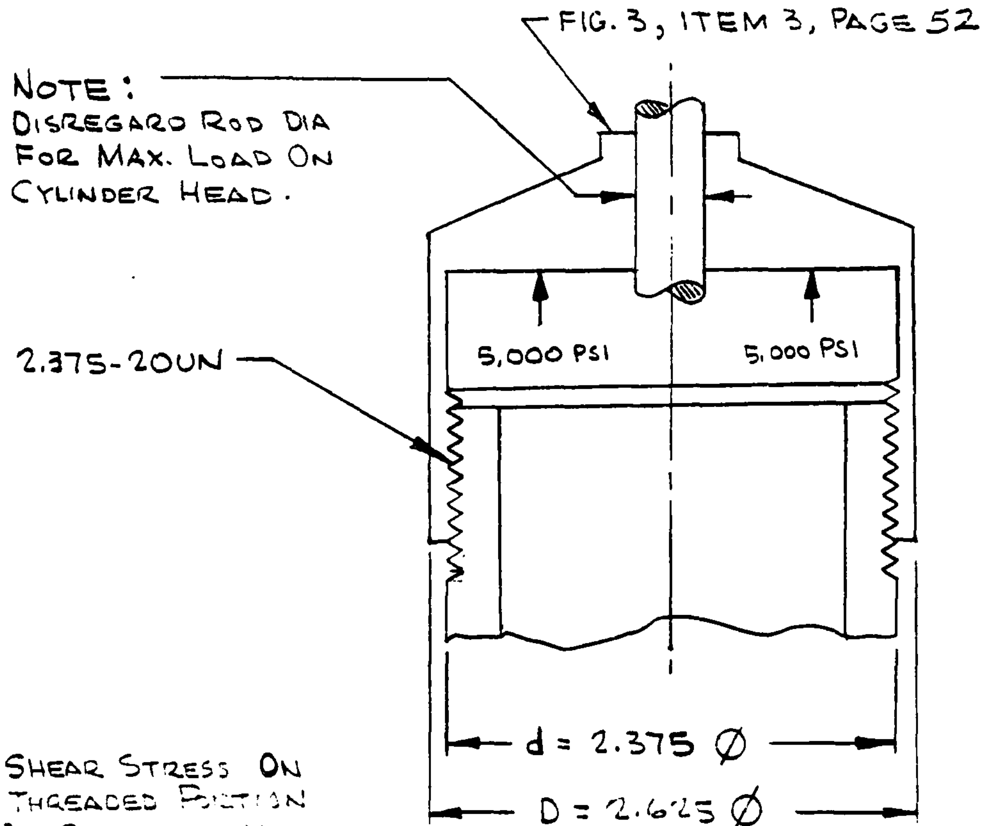
$$= \frac{80{,}000 \text{ PSI}}{20{,}842 \text{ PSI}}$$

$$SF = \underline{\underline{3.84}}$$

2.2 THREADED CYLINDER HEAD

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46.

SOLVING FOR SF



SHEAR STRESS ON THREADED PORTION OF CYLINDER HEAD

$T_L = P_x A$, $A = 4.4301$ (FROM PAGE 9)

$T_L = \underline{22{,}151 \text{ LB}}$ (FROM PAGE 9)

$T_A = \pi \, P_D \, \frac{P}{2} n$

$T_A = \pi(2.3425)\left(\frac{.05}{2}\right)(20)$

$T_A = \underline{3.6796 \text{ IN}^2}$

$T_S = \frac{T_L}{T_A} = \frac{22{,}151 \text{ LB}}{3.6796 \text{ PSI}}$

$T_S = \underline{6{,}020 \text{ PSI}}$

$\text{EXISTING SF} = \frac{\sigma_S}{T_S}$

$= \frac{15{,}000 \text{ PSI}}{6{,}020 \text{ PSI}}$

$SF = \underline{\underline{2.49}}$

TENSILE LOAD ON THREAD RELIEF AREA OF HEAD @ 5,000 PSI & 2000 PSI CYLINDER PRESSURE.

T_L @ 5,000 PSI = 22,151 LB (FROM PAGE 9)

$T_A = \frac{\pi}{4} D^2 - \frac{\pi}{4} d^2$

$= (.7854)\left[(2.625)^2 - (2.375)^2\right]$

$= (.7854\left[(6.890625) - (5.640625)\right]$

$T_A = \underline{.9817 \text{ IN}^2}$

$T_S = \frac{T_L}{T_A}$

$= \frac{22{,}151 \text{ LB}}{.9817 \text{ IN}^2}$

$T_S = \underline{22{,}564 \text{ PSI}}$

$\text{EXISTING SF} = \frac{\sigma_{ULT}}{T_S}$

$= \frac{80{,}000 \text{ PSI}}{22{,}564 \text{ PSI}}$

$SF = \underline{\underline{3.55}}$

$$T_L @ 2000\ PSI = P_Y(A) \qquad A = 4.4301\ IN^2\ (\text{FROM PAGE 9})$$

$$= 2000\ LBS/IN^2 \times 4.4301\ IN^2$$

$$T_L = \underline{8860\ LBS} \longleftarrow$$

$$T_A = \underline{.9817\ IN^2} \longleftarrow \quad (\text{FROM PAGE 11})$$

$$T_S = \frac{T_L}{T_A}$$

$$= \frac{8860\ LBS}{.9817\ IN^2}$$

$$T_S = \underline{9025\ LBS/IN^2} \longleftarrow$$

$$\text{EXISTING SF} = \frac{\sigma_Y}{T_S}$$

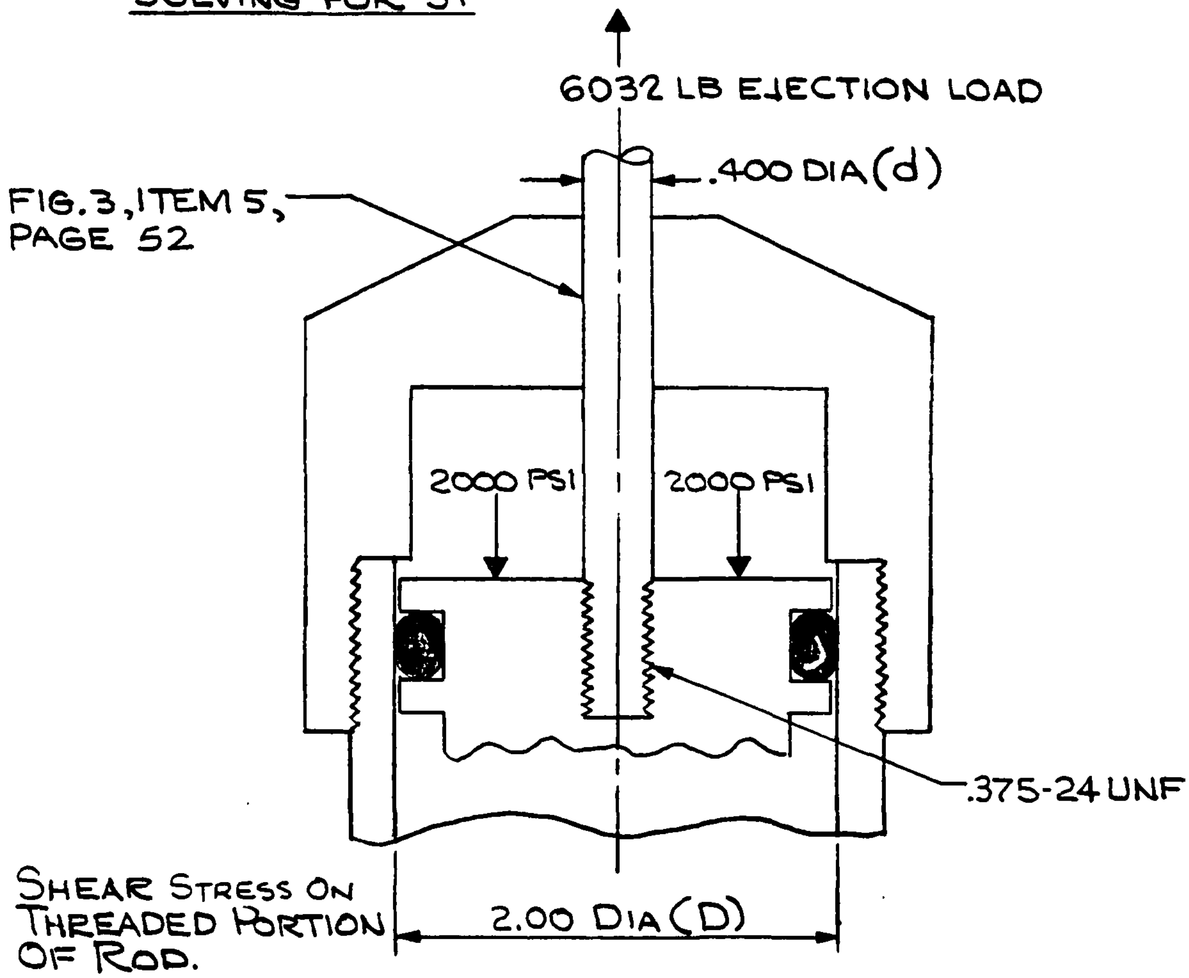
$$= \frac{30{,}000\ LBS/IN^2}{9{,}025\ LBS/IN^2}$$

$$SF = \underline{\underline{3.32}} \longleftarrow$$

2.3 TRACTION ROD

MATERIAL: SEE TABLE 8.1, ITEM 2, PAGE 46

SOLVING FOR SF



$T_L = P_Y(A) \quad A = \frac{\pi}{4}D^2 - \frac{\pi}{4}d^2 = .7854(2.00)^2 - .7854(.400)^2 = 3.016 \text{ IN}^2$

$= 2000 \text{ LBS/IN}^2 \times 3.016 \text{ IN}^2$

$T_L = \underline{6032 \text{ LBS}}$

$T_A = \pi P_D \left(\frac{p}{2}\right)(n) \quad P_D = .3430,\ p = .04167,\ n = 16.5$

$= 3.1416 \times .3430 \left(\frac{.04167}{2}\right) \times 16.5$

$= 3.1416 \times .3430 \times .0208 \times 16.5$

$T_A = \underline{.3698 \text{ IN}^2}$ ←

$T_S = \frac{T_L}{T_A}$

$= \frac{6032 \text{ LBS}}{.3698 \text{ IN}^2}$

$T_S = \underline{16{,}311 \text{ LBS/IN}^2}$ ←

EXISTING $SF = \frac{\sigma_S}{T_S}$

$= \frac{72{,}500 \text{ LBS/IN}^2}{16{,}311 \text{ LBS/IN}^2}$

$SF = \underline{\underline{4.44}}$ ←

TENSILE STRESS ON ROD USING MINOR THREAD DIA

NOTE: $T_L = \underline{6032 \text{ LBS}}$ ←

$T_A = \frac{\pi}{4}(.3228)^2$ NOTE: .3228 = MINOR THREAD DIA.

$= .7854 \times .1042$

$T_A = \underline{.0818 \text{ IN}^2}$ ←

$T_S = \frac{T_L}{T_A}$

$= \frac{6032 \text{ LBS}}{.0818 \text{ IN}^2}$

$T_S = \underline{73{,}740 \text{ LBS/IN}^2}$ ←

EXISTING $SF = \frac{\sigma_Y}{T_S} = \frac{145{,}000 \text{ LBS/IN}^2}{73{,}740 \text{ LBS/IN}^2} = \underline{\underline{1.97}}$ ←

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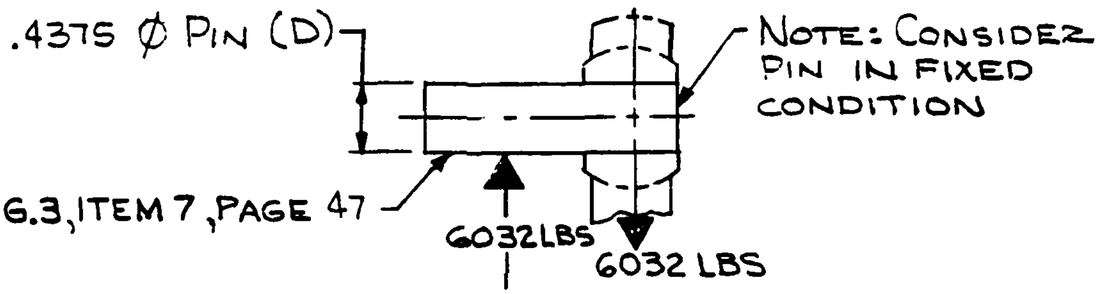
2.4 THREADED HOLE, PISTON, CYLINDER

NOTE: THE PISTON & ROD MATERIAL IS IDENTICAL SO THE PREVIOUS THREAD CALCULATIONS FOR THE ROD (PAGES 8 & 9) ALSO APPLY TO THE PISTON THREADS.

2.5 PIN, ROD END

MATERIAL: SEE TABLE 8.1, ITEM 2, PAGE 46

SOLVING FOR SF



$S_L = T_L \quad T_L = 6032$ LBS (FROM PAGE 13)

$S_L = \underline{6032 \text{ LBS}}$ ←

$S_A = \frac{\pi}{4} D^2$

$= .7854(.4375)^2$

$= .7854 \times .1914$

$S_A = \underline{.1503 \text{ IN}^2}$ ←

$S_S = \frac{S_L}{S_A}$

$= \frac{6032 \text{ LBS}}{.1503 \text{ IN}^2}$

$S_S = \underline{40{,}133 \text{ LBS/IN}^2}$ ←

EXISTING SF $= \frac{\sigma_S}{S_S} = \frac{72{,}500 \text{ LBS/IN}^2}{40{,}133 \text{ LBS/IN}^2} = \underline{\underline{1.806}}$ ←

2.6 ROD END, THREADED

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46

SOLVING FOR SF

$$T_A = \frac{\pi}{4}\left[(.562)^2 - (.375)^2\right]$$

$$T_A = \underline{.1376 \text{ IN}^2}$$

T_L = 6,032 LBS (FROM PAGE 13)

$$T_S = \frac{T_L}{T_A}$$

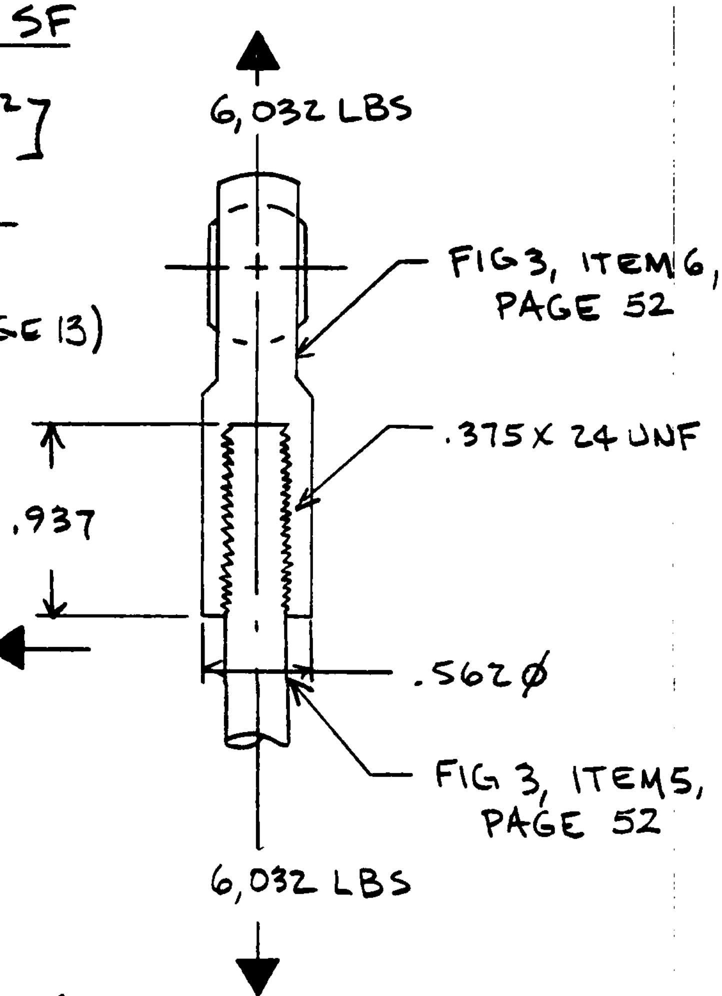
$$= \frac{6{,}032 \text{ LBS}}{.1376 \text{ IN}^2}$$

$$T_S = \underline{43{,}837 \text{ LBS/IN}^2}$$

$$\sigma_{ULT} = \frac{11{,}250 \text{ LB}}{\text{IN}^2}$$

$$= \frac{11{,}250}{.1376}$$

$$\sigma_{ULT} = \underline{81{,}759 \text{ LBS/IN}^2}$$



$$\text{EXISTING SF} = \frac{81{,}759 \text{ LBS/IN}^2}{43{,}837 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{1.87}}$$

NOTE: 11,250 LB WAS OBTAINED FROM VENDOR SPEC, REF. SOUTHWEST PRODUCTS CO., P/N 2DREF-6.

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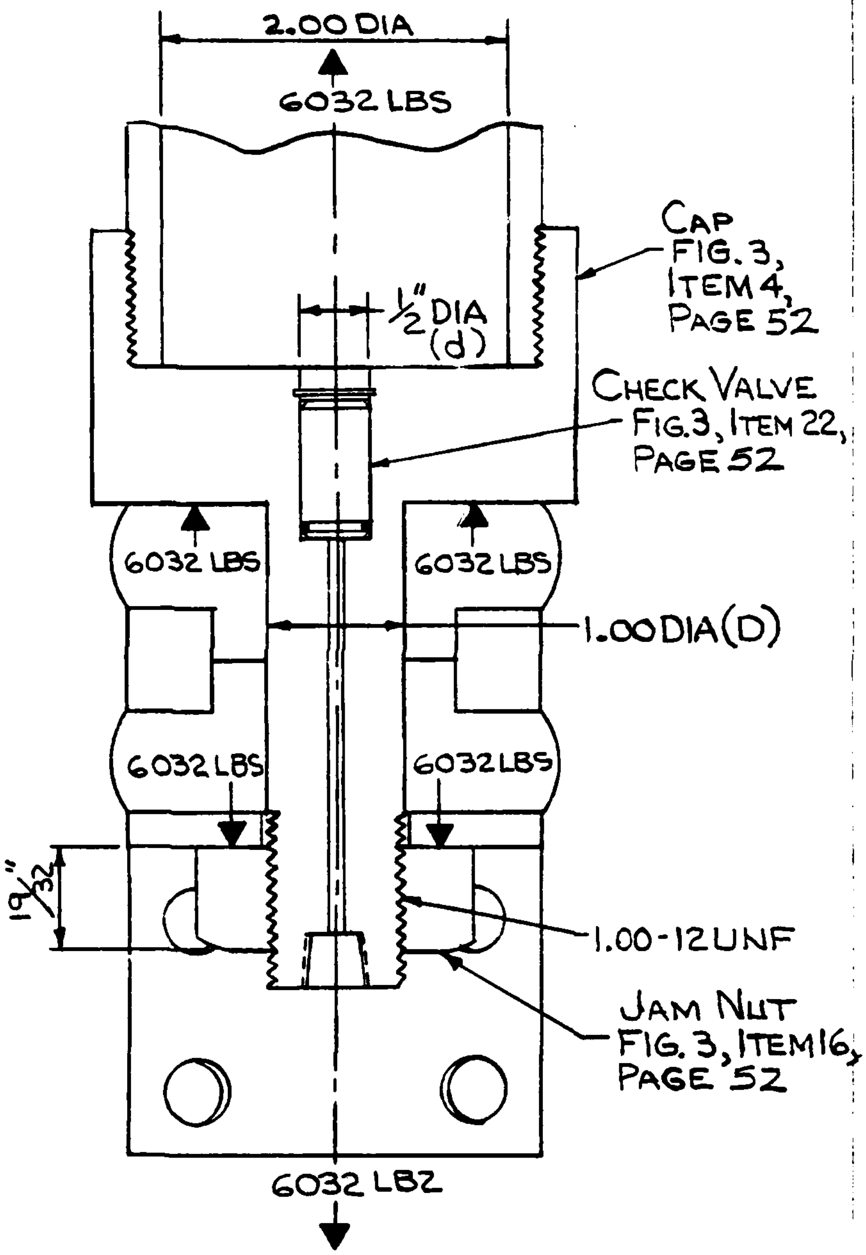
2.7 CAP, CYLINDER

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46

SOLVING FOR SF



NOTE: THE INSIDE DIA THREADS ON THE CYLINDER CAP & HEAD ARE IDENTICAL SO THE PREVIOUS THREAD CALCULATIONS FOR THE HEAD (PAGES 13 & 14) ALSO APPLY TO THE CYLINDER CAP.

CONSIDER THE TENSILE STRESS ON THE THINNEST WALL SECTION IN THE CHECK VALVE AREA OF THE CYLINDER CAP.

NOTE: T_L = 6032 LBS ← (FROM T_L ON PAGE 13)

$$T_A = \frac{\pi}{4} D^2 - \frac{\pi}{4} d^2$$

$$= .7854(1.00)^2 - .7854(.500)^2$$

$$= .7854 - .19635$$

$$T_A = \underline{.589} \leftarrow$$

$$T_S = \frac{T_L}{T_A}$$

$$= \frac{6032 \text{ LBS.}}{.589}$$

$$T_S = \underline{10{,}241 \text{ LBS/IN}^2} \leftarrow$$

$$\text{EXISTING SF} = \frac{\sigma_Y}{T_S}$$

$$= \frac{30{,}000 \text{ LBS/IN}^2}{10{,}241 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{2.93}} \leftarrow$$

CONSIDER THE SHEAR STRESS ON JAM NUT THREADS.

NOTE: T_L = 6032 LBS ← (FROM T_L ON PAGE 13)

$$T_A = \pi P_D \left(\frac{p}{2}\right)(n) \quad P_D = .9459,\ p = .0833,\ n = 7.125$$

$$= 3.1416 \times .9459 \times \left(\frac{.0833}{2}\right) \times 7.125$$

$$= 3.1416 \times .9459 \times .0416 \times 7.125$$

$$T_A = \underline{.880 \text{ IN}^2} \leftarrow$$

$$T_S = \frac{T_L}{T_A}$$

$$= \frac{6032 \text{ LBS}}{.880 \text{ IN}^2}$$

$$T_S = \underline{6854 \text{ LBS/IN}^2}$$

$$\text{EXISTING SF} = \frac{\sigma_S}{T_S}$$

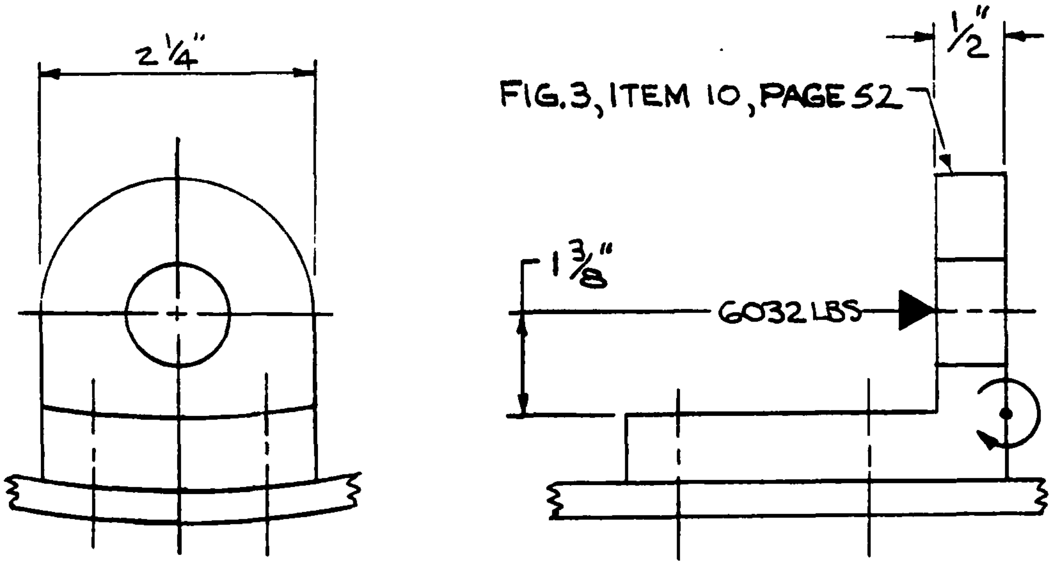
$$= \frac{15{,}000 \text{ LBS/IN}^2}{6{,}854 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{2.19}}$$

2.8 BRACKET, CYLINDER

MATERIAL: SEE TABLE 8.1, ITEM 2, PAGE 46

SOLVING FOR SF



BENDING @ 2000 PSI = 6032 LBS (PAGE 13)

$$S_B = \frac{M}{Z}$$

$$S_B = \frac{8294 \text{ IN-LBS}}{.09375 \text{ IN}^3}$$

$$S_B = \underline{88{,}470 \text{ LBS/IN}^2}$$

$M = 6032 \text{ LBS} \times 1.375 \text{ INS.}$
$= \underline{8294 \text{ IN-LBS}}$

$Z = \frac{bd^2}{6}$ $b = 2.25 \text{ INS.}$, $d = .50 \text{ INS.}$.

$$= \frac{(2.25)(.50)^2}{6}$$

$$= \frac{2.25 \text{ INS} \times .25 \text{ IN}^2}{6}$$

$$= \underline{.09375 \text{ IN}^3}$$

$$\text{EXISTING SF} = \frac{\sigma_Y}{S_B}$$

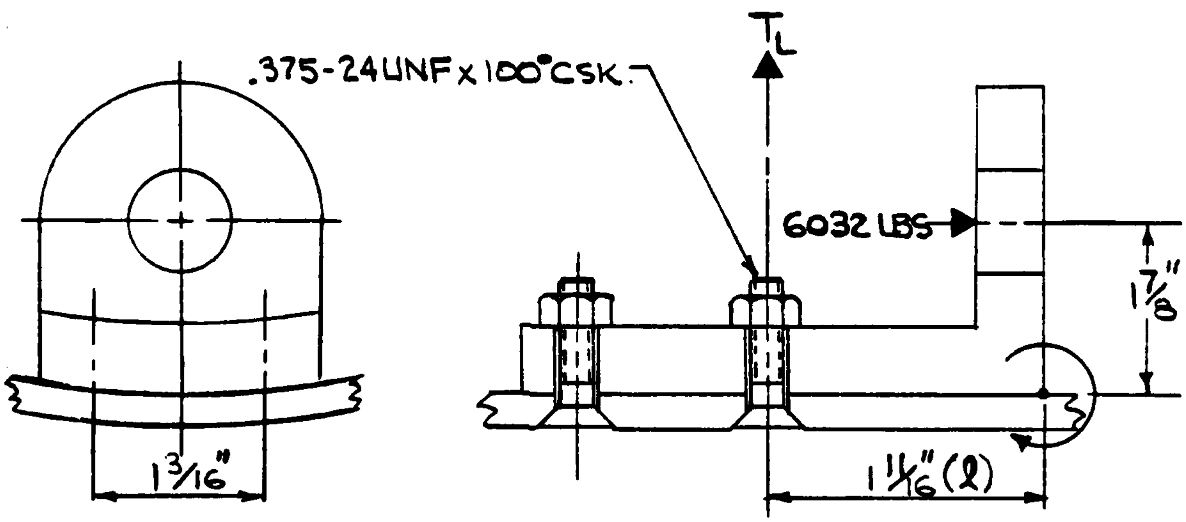
$$= \frac{145{,}000 \text{ LBS/IN}^2}{88{,}470 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{1.64}}$$

2.9 MOUNTING SCREWS, BRACKET, CYLINDER

MATERIAL: SEE TABLE 8.1, ITEM 4, PAGE 46

SOLVING FOR SF



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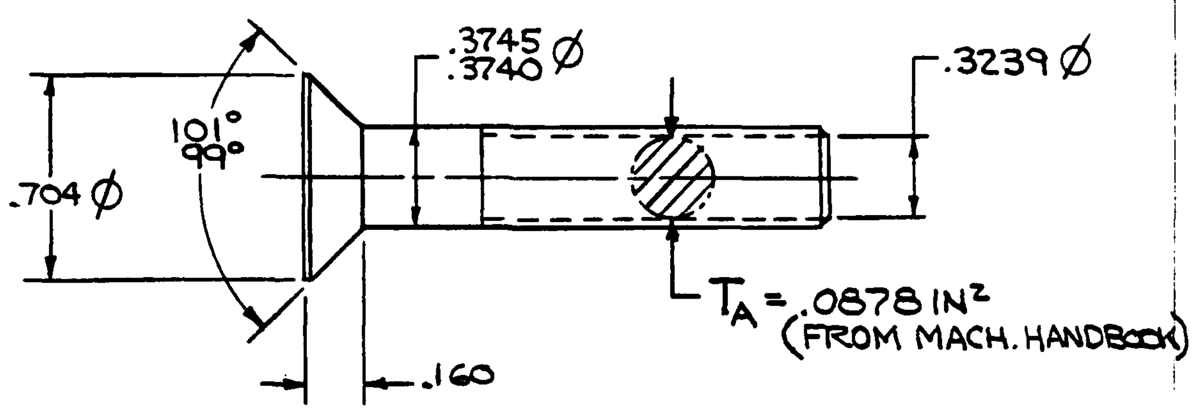


CONSIDER 2 SCREWS ARE TAKING THE TOTAL LOAD IN TENSION THEN CHECK THE T_S & SF/SCREW.

$$T_L = \frac{1}{2}\left[\frac{M}{\ell}\right] \qquad M = 6032 \text{ LBS} \times 1.875 \text{ INS} = 11{,}310 \text{ IN-LBS}$$

$$\ell = 1.6875 \text{ INS.}$$

$$= .5\left[\frac{11{,}310 \text{ IN-LBS.}}{1.6875 \text{ INS}}\right]$$

$$= .5 \times 6702 \text{ LBS}$$

$$T_L = \underline{3{,}351 \text{ LBS}} \leftarrow$$

$$T_A = \underline{.0878 \text{ IN}^2} \leftarrow$$

$$T_S = \frac{T_L}{T_A}$$

$$= \frac{3{,}351 \text{ LBS}}{.0878 \text{ IN}^2}$$

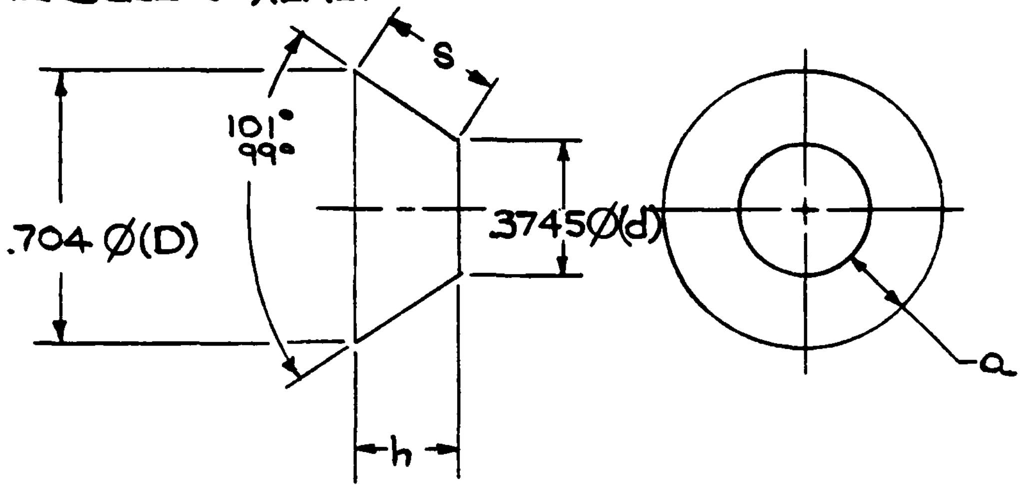
$$T_S = \underline{38{,}166 \text{ LBS/IN}^2} \leftarrow$$

$$\text{EXISTING SF} = \frac{\sigma_Y}{T_S}$$

$$= \frac{91{,}000 \text{ LBS/IN}^2}{38{,}166 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{2.38}} \leftarrow$$

CONSIDER THE MAX. BEARING LOAD ON THE SKIN RESULTING FROM THE PROJECTED AREA UNDER THE SCREW HEAD.



AREA OF CONICAL SURFACE (IN^2), FROM MACHINERY HANDBOOK

$A = 1.5708\, s(D+d)$ $\qquad s = \sqrt{a^2+h^2}$ $\qquad a = \frac{1}{2}(D-d)$

$A = 1.5708(.2162)(.704+.3745)$ $\qquad s = \sqrt{(.16475)^2+(.140)^2}$ $\qquad a = .5(.704-.3745)$

$A = 1.5708(.2162)(1.0785)$ $\qquad s = \sqrt{.02714+.0196}$ $\qquad a = .16475$ INS.

$A = \underline{.366\ IN^2} \longleftarrow$ $\qquad s = \sqrt{.04674}$ $\qquad h = .160 - .020$

$s = \underline{.2162\ INS.} \longleftarrow$ $\qquad h = \underline{.140\ INS.} \longleftarrow$

$B_L = T_L \quad T_L = 3{,}351$ LBS (FROM PAGE 16)

$B_L = \underline{3{,}351\ LBS} \longleftarrow$

$B_A = A \quad A = .366\ IN^2$

$B_A = \underline{.366\ IN^2} \longleftarrow$

$$B_S = \frac{B_L}{B_A} = \frac{3351\ LBS}{.366\ IN^2}$$

$B_S = \underline{9{,}155\ LBS/IN^2} \longleftarrow$

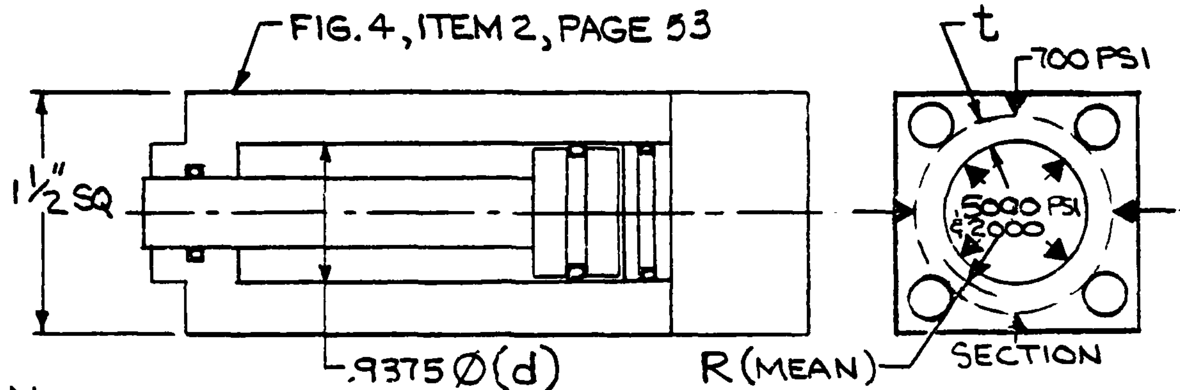
$$\text{EXISTING SF} = \frac{\sigma_{YB}}{B_S} = \frac{56{,}000\ LBS/IN^2}{9{,}155\ LBS/IN^2} = \underline{\underline{6.12}} \longleftarrow$$

3.0 WARM CABLE CUTTER ASSEMBLY

3.1 PISTON HOUSING

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46

SOLVING FOR SF



NOTE:
THE PISTON HOUSING IS $1\frac{1}{2}''$ SQUARE BUT BECAUSE OF 4 DRILLED HOLES THRU THE HOUSING ASSUME A CYLINDRICAL TUBE OF $1\frac{5}{32}''$ O.D. X $\frac{15}{16}''$ I.D. FOR THE FOLLOWING CALCULATIONS.

STRESS FROM INTERNAL PRESSURES @ P_x & σ_{ULT}

$S_2 = \frac{P_x R}{t}$ $P_x = 5000$ LBS/IN^2, $R = .5235$ INS., $t = .1094$ INS.

$$= \frac{5000 \text{ LBS/IN}^2 \times .5235 \text{ INS}}{.1094 \text{ INS}}$$

$$S_2 = \underline{23{,}926 \text{ LBS/IN}^2}$$

$$\text{EXISTING SF} = \frac{\sigma_{ULT}}{S_2}$$

$$= \frac{80{,}000 \text{ LBS/IN}^2}{23{,}926 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{3.34}}$$

INTERNAL STRESS @ P_Y & σ_Y

$$S_2 = \frac{P_Y R}{t} \quad P_Y = 2000 \text{ LBS/IN}^2, R = .5235 \text{ INS.}, t = .1094 \text{ INS.}$$

$$= \frac{2000 \text{ LBS/IN}^2 \times .5235 \text{ INS}}{.1094 \text{ INS}}$$

$$S_2 = \underline{9570 \text{ LBS/IN}^2} \longleftarrow$$

$$\text{EXISTING SF} = \frac{\sigma_Y}{S_2}$$

$$= \frac{30\,000 \text{ LBS/IN}^2}{9570 \text{ LBS/IN}^2}$$

$$\text{SF} = \underline{\underline{3.13}} \longleftarrow$$

STRESS FROM EXTERNAL PRESSURE @ P_Z & P'

$$P' = \frac{t}{R}\left[\frac{\sigma_Y}{1 + 4\left(\frac{\sigma_Y}{E}\right)\left(\frac{R}{t}\right)^2}\right]$$

$$P' = \frac{.1094}{.5235}\left[\frac{30 \times 10^3}{1 + 4\left(\frac{30 \times 10^3}{28 \times 10^6}\right)\left(\frac{.5235}{.1094}\right)}\right]$$

$$P' = .2089\left[\frac{30 \times 10^3}{1 + 4.2857 \times 10^{-3} \times 4.785}\right]$$

$$P' = .2089\left[\frac{30 \times 10^3}{1.0205}\right]$$

$$P' = \underline{6141 \text{ LBS/IN}^2} \longleftarrow$$

$$\text{EXISTING SF} = \frac{P'}{P_Z} = \frac{6141 \text{ LBS/IN}^2}{700 \text{ LBS/IN}^2} = \underline{\underline{8.77}} \longleftarrow$$

3.2 FASTENERS, PISTON CLOSURE

MATERIAL : SEE TABLE 8.1, ITEM 3, PAGE 46

SOLVING FOR SF

FASTENER; MS9706-35, 1/4-28UNF x 2 3/4" LONG, 4 REQ'D., FIG. 4, ITEM 12, PAGE 53

CONSIDER THE SHEAR STRESS ON FASTENER THREADS

$T_L = P_x A \quad A = \frac{\pi}{4}(d)^2 = .7854(.9375)^2 = \underline{.690\ IN^2}$ ←

$= 5000\ LBS/IN^2 \times .690\ IN^2$

$T_L = \frac{3450\ LBS}{4\ BOLTS} = \underline{862.5\ LBS}$ ←

$T_A = \pi P_D\left(\frac{p}{2}\right)(n) \quad P_D = .2225,\ p = .03571,\ n = 8.75$

$= 3.1416 \times .2225\left(\frac{.03571}{2}\right) 8.75$

$= 3.1416 \times .2225 \times .017855 \times 8.75$

$T_A = \underline{.1092\ IN^2}$ ←

$T_S = \frac{T_L}{T_A}$

$= \frac{862.5\ LBS}{.1092\ IN^2}$

$T_S = \underline{7898\ LBS/IN^2}$ ←

EXISTING SF $= \frac{\sigma_S}{T_S}$

$= \frac{57{,}500\ LBS/IN^2}{7{,}898\ LBS/IN^2}$

SF $= \underline{\underline{7.28}}$ ←

CONSIDER TENSILE STRESS ON MINIMUM THREADED DIA.

$T_L = \underline{862.5 \text{ LBS}}$ ← (FROM PAGE 20)

$T_A = \frac{\pi}{4} D^2$ D = MINOR THREAD DIA = .2062 IN.

$= .7854(.2062)^2$

$= .7854 \times .04252$

$T_A = \underline{.0334 \text{ IN}^2}$ ←

$T_S = \frac{T_L}{T_A}$

$= \frac{862.5 \text{ LBS}}{.0334 \text{ IN}^2}$

$T_S = 25{,}823 \text{ LBS/IN}^2$

EXISTING $SF = \frac{\sigma_{ULT}}{T_S}$

$= \frac{155{,}000 \text{ LBS/IN}^2}{25{,}823 \text{ LBS/IN}^2}$

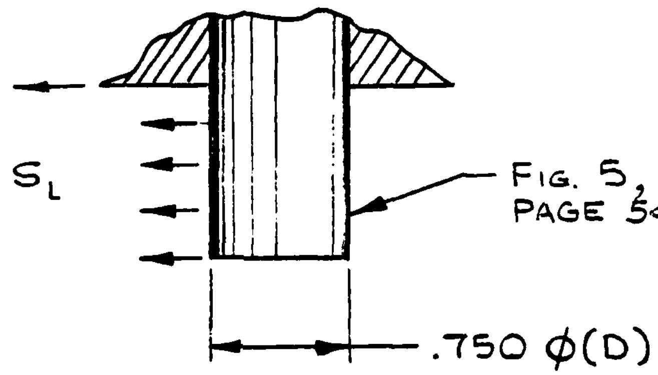
$SF = \underline{\underline{6.00}}$ ←

4.0 DETENT ASSEMBLY

4.1 DETENT PIN

MATERIAL: SEE TABLE 8.1, ITEM 2, PAGE 46

SOLVING FOR SF ON HANDLING SHEAR



$S_L = P_H = \underline{25{,}000 \text{ LB}}$

$S_A = \frac{\pi}{4} D^2$

$= (.785)(.750)^2$

$= (.7854)(.5625)$

$= \underline{.4418 \text{ IN}^2}$

$S_S = \frac{S_L}{S_A} = \frac{25{,}000}{.4418} = \underline{56{,}587 \text{ LBS/IN}^2}$

$SF = \frac{\sigma_S}{S_S}$

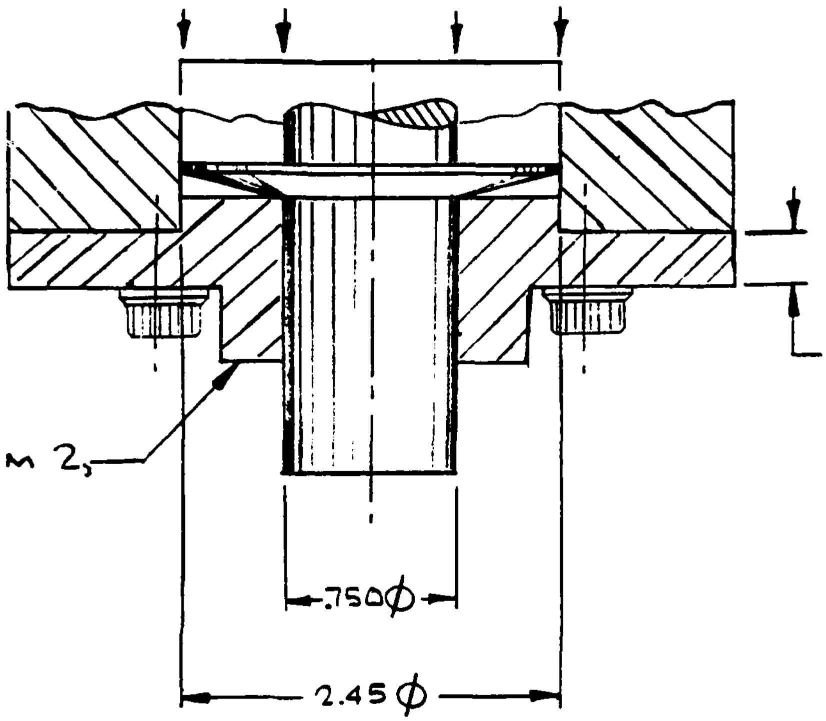
$= \frac{72{,}500 \text{ LBS/IN}^2}{56{,}587 \text{ LBS/IN}^2}$

$SF = \underline{\underline{1.28}}$

4.2 COVER

SOLVING FOR DEFLECTION

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46



$$\text{MAX } y \text{ AT } P_x = \frac{3(P_x)(m^2-1)}{16 m^2 E t^3}$$

$$\therefore \text{MAX } y = \frac{(3)(5000)\left[\left(\frac{1}{.26}\right)^2-1\right]}{16\left(\frac{1}{.26}\right)^2(28\times10^6)(.375)^3}$$

$$= \frac{(3)(5000)\left[(3.8462)^2-1\right]}{16(3.8462)^2(28\times10^6)(.0527)}$$

$$= \frac{(3)(5000)(13.7933)}{(12.4818)\ (28\times10^6)}$$

$$= \frac{206899.5}{349.4906\times10^6} = \underline{.000592 \text{ INS.}}$$

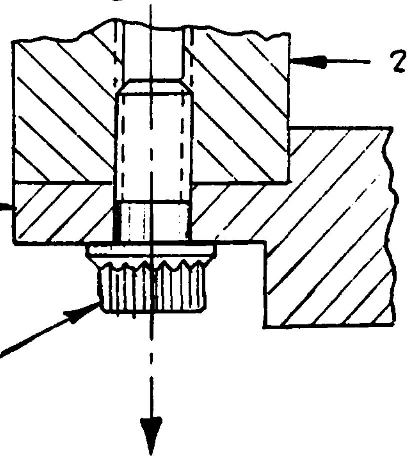
$$\text{MAX } y \text{ AT } P_Y = \frac{(3)P_Y(13.7933)}{349.4906 \times 10^6}$$

$$= \frac{(3)(2000)(13.7933)}{349.4906 \times 10^6}$$

$$= \frac{82759.8}{349.4906 \times 10^6} = \underline{.0002368 \text{ INS}}$$

4.3 FASTENERS, COVER (4 REQ'D)

MATERIAL: SEE TABLE 8.1, ITEM 6, PAGE 46



SOLVING FOR SF AT P_x & σ_{ULT} AND P_Y & σ_y:

T_A = .0878 IN^2 (MACHINERY'S HANDBOOK)

$$T_L \text{ AT } P_x = \frac{\pi}{4}(2.45)^2(P_x)$$

$$= (.7854)(6.0025)(5000) = \underline{23{,}572 \text{ LB}}$$

$$T_L \text{ AT } P_Y = \frac{\pi}{4}(2.45)^2(P_Y)$$

$$= (.7854)(6.0025)(2000) = \underline{9{,}429 \text{ LB}}$$

$$T_S \text{ AT } P_X = \frac{T_L}{(4)(T_A)} = \frac{23,572}{(4)(.0878)}$$

$$= \frac{23,572}{.3512} = \underline{67,118 \text{ LBS/IN}^2} \longleftarrow$$

$$\therefore \text{SF AT } P_X \,\&\, \sigma_{ULT} = \frac{\sigma_{ULT}}{T_S}$$

$$= \frac{175,000 \text{ LBS/IN}^2}{67,118 \text{ LBS/IN}^2}$$

$$\text{SF} = \underline{\underline{2.61}} \longleftarrow$$

$$T_S \text{ AT } P_Y = \frac{T_L}{(4)(T_A)} = \frac{9429}{(4)(.0878)}$$

$$= \frac{9429}{.3512} = \underline{26,848 \text{ LBS/IN}^2}$$

$$\therefore \text{SF AT } P_Y \,\&\, \sigma_y = \frac{\sigma_y}{T_S}$$

$$= \frac{115,000 \text{ LBS/IN}^2}{26,848 \text{ LBS/IN}^2}$$

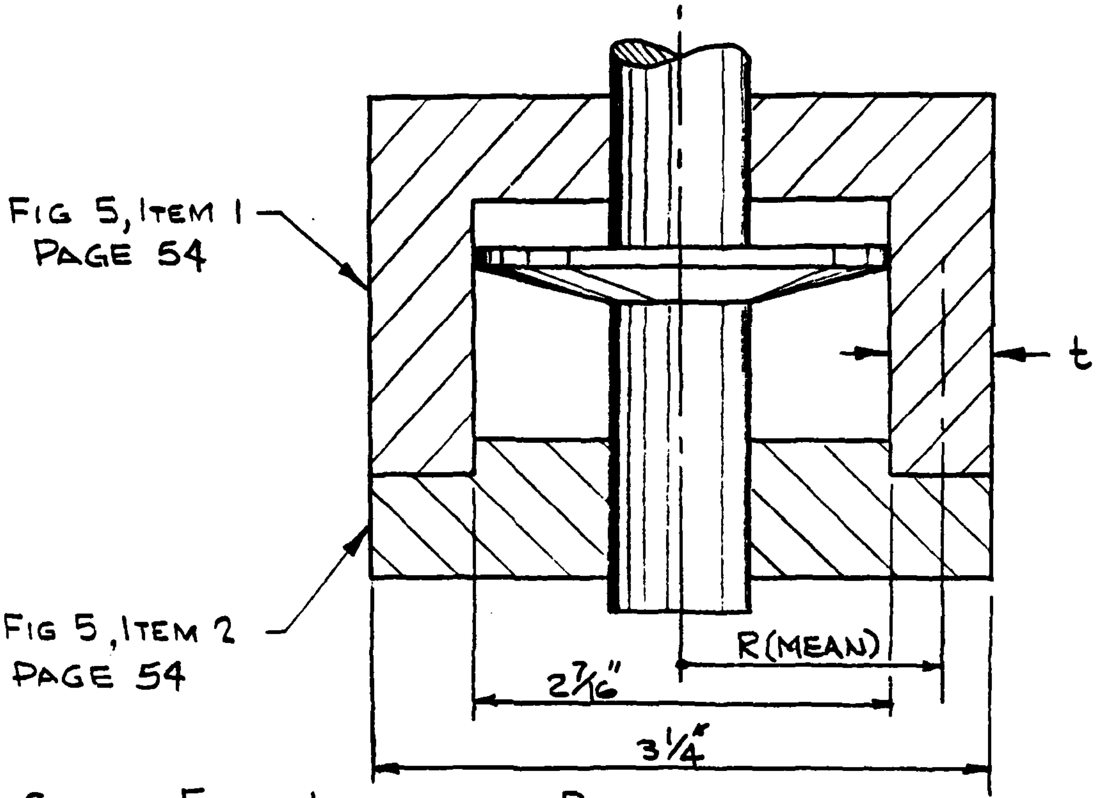
$$\text{SF} = \underline{\underline{4.28}} \longleftarrow$$

4.4 HOUSING:

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46

SOLVING FOR SF

NOTE: ALTHOUGH THE DETENT HOUSING IS RECTANGULAR THE FOLLOWING CALCULATIONS WILL BE BASED ON A CYLINDRICAL SHAPE OF 3 1/4" O.D. x 2 7/16" I.D.



STRESS FROM INTERNAL PRESSURES

$S_2 \text{ w/} P_Y = \dfrac{P_Y R}{t}$ $P_Y = 2000$ LBS/IN², $R = 1.4219$ INS., $t = .4062$ INS.

$= \dfrac{2000 \text{ LBS/IN}^2 \times 1.4219 \text{ INS}}{.4062 \text{ INS.}}$

$S_2 = \underline{7000 \text{ LBS/IN}^2}$

EXISTING $SF = \dfrac{\sigma_Y}{S_2}$

$= \dfrac{30{,}000 \text{ LBS/IN}^2}{7{,}000 \text{ LBS/IN}^2}$

$SF = \underline{\underline{4.29}}$

$$S_2 \text{ w}/P_X = \frac{P_X R}{t} \quad P_X = 5000 \text{ LBS/IN}^2,\ R = 1.4219 \text{ INS.},\ t = .4062 \text{ INS}$$

$$= \frac{5000 \text{ LBS/IN}^2 \times 1.4219 \text{ INS.}}{.4062 \text{ INS.}}$$

$$S_2 = \underline{17{,}502 \text{ LBS/IN}^2} \longleftarrow$$

$$\text{EXISTING SF} = \frac{\sigma_{ULT}}{S_2}$$

$$= \frac{80{,}000 \text{ LBS/IN}^2}{17{,}502 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{4.57}} \longleftarrow$$

STRESS FROM EXTERNAL PRESSURE

$$P' = \frac{t}{R}\left[\frac{\sigma_Y}{1+4\left(\frac{\sigma_Y}{E}\right)\left(\frac{R}{t}\right)^2}\right]$$

$$= \frac{.4062}{1.4219}\left[\frac{30\times10^3}{1+4\left(\frac{145\times10^3}{28\times10^6}\right)\left(\frac{1.4219}{.4062}\right)^2}\right]$$

$$= .2856\left[\frac{30\times10^3}{1+2.0714\times10^{-2}(12.2534)}\right]$$

$$= .2856\left[\frac{30\times10^3}{1.25382}\right]$$

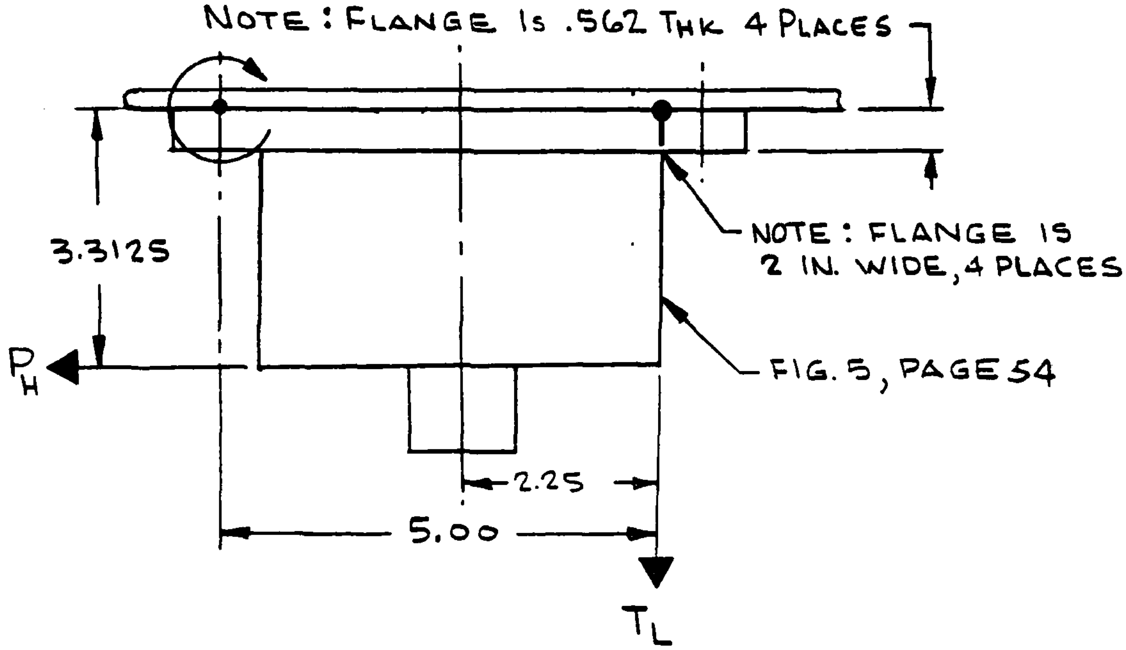
$$P' = \underline{6{,}833 \text{ LBS/IN}^2} \longleftarrow$$

$$\text{EXISTING SF} = \frac{P'}{P_Z}$$

$$= \frac{6{,}833 \text{ LB/IN}^2}{700 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{9.76}} \longleftarrow$$

NOTE: CHECK THE SHEAR STRESS ON THE HOUSING FLANGE USING THE HANDLING LOAD (P_H).



$$T_L = \frac{M}{\ell}, \quad M = (P_H)(\text{ARM}) = (25{,}000)(3.3125) = 89062.5 \text{ IN-LB}$$

$$\ell = 5.00 \text{ IN.}$$

$$T_L = \frac{89{,}062.5 \text{ IN-LB}}{5.00 \text{ IN.}}$$

$$T_L = \underline{17{,}813 \text{ LB}} \longleftarrow$$

$$T_A = .5625 \text{ IN.} \times 2.00 \text{ IN.} \times 2 \text{ FLANGES}$$

$$T_A = \underline{2.250 \text{ IN}^2} \longleftarrow$$

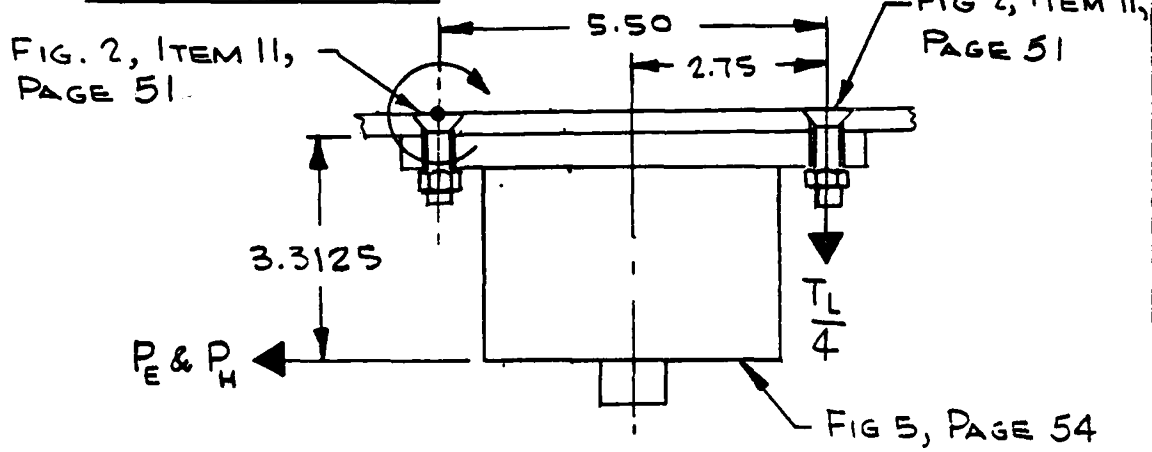
$$T_S = \frac{T_L}{T_A} = \frac{17{,}813 \text{ LB}}{2.250 \text{ IN}^2} = \underline{7{,}917 \text{ PSI}} \longleftarrow$$

$$\text{EXISTING SF} = \frac{\sigma_S}{T_S} = \frac{15{,}000 \text{ PSI}}{7{,}917 \text{ PSI}} = \underline{\underline{1.89}} \longleftarrow$$

4.5 FASTENERS, MOUNTING

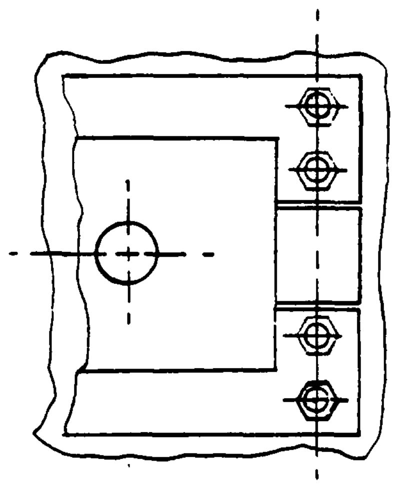
MATERIAL: SEE TABLE 8.1, ITEM 4, PAGE 46

SOLVING FOR SF



$P_E = 6{,}032$ LB
EJECTION LOAD

$P_H = 25{,}000$ LB
HANDLING LOAD



NOTE: IN THE FOLLOWING CALCULATIONS CONSIDER ONE SIDE FREE & THE OTHER SIDE HINGED WITH 4 SCREWS TAKING THE TOTAL LOAD IN TENSION THEN CHECK THE T_S & SF PER SCREW USING P_E & P_H.

$T_L \text{ w}/P_E = \frac{1}{4}\left[\frac{M}{\ell}\right]$ $M = P_E \times ARM = 6032\text{LBS} \times 3.3125\text{INS} = 19{,}981 \text{ IN-LBS}$

$\ell = 5.50 \text{ IN.}$

$= .25\left[\frac{19{,}981 \text{ IN-LBS}}{5.50 \text{ IN.}}\right]$

$= .25 \times 3633 \text{ LB}$

$T_L = \underline{908.25\text{LBS}} \leftarrow$

$T_A = \underline{.0878 \text{ IN}^2} \leftarrow$ (FROM MACHINERY HANDBOOK)

$T_S = \frac{T_L}{T_A}$

$= \frac{908.25\text{LBS}}{.0878 \text{ IN}^2}$

$T_S = \underline{10{,}345 \text{LBS/IN}^2} \leftarrow$

EXISTING $SF = \frac{\sigma_Y}{T_S}$

$= \frac{91{,}000 \text{ LBS/IN}^2}{10{,}345 \text{LBS/IN}^2}$

$SF = \underline{\underline{8.80}} \leftarrow$

$T_L \text{ W}/P_H = \frac{1}{4}\left[\frac{M}{\ell}\right]$ $M = P_H \times ARM = 25000\text{LBS} \times 3.3125\text{INS} = 82812 \text{IN-LBS}$

$\ell = 5.50 \text{ IN.}$

$= .25\left[\frac{82{,}812 \text{ IN-LBS}}{5.50 \text{ IN.}}\right]$

$= .25 \times 15{,}057 \text{LBS}$

$T_L = \underline{3764.3 \text{ LBS}} \leftarrow$

$T_A = \underline{.0878 \text{ IN}^2} \leftarrow$ (FROM MACHINERY HANDBOOK)

$T_S = \frac{T_L}{T_A}$

$$T_S = \frac{3764.3\ LB}{.0878\ IN^2}$$

$$T_S = \underline{42{,}874\ LBS/IN^2} \longleftarrow$$

$$\text{EXISTING SF} = \frac{\sigma_Y}{T_S}$$

$$= \frac{91{,}000\ LBS/IN^2}{42{,}874\ LBS/IN^2}$$

$$SF = \underline{\underline{2.12}} \longleftarrow$$

CONSIDER THE MAX. BEARING STRESS ON THE SKIN RESULTING FROM THE PROJECTED AREA UNDER THE SCREW HEAD USING $T_L w/P_E = 908.25\ LB$ & $T_L w/P_H = 3764\ LB$

$A = \underline{.366\ IN^2} \longleftarrow$ (FROM PAGE 22)

$$B_L = T_L w/P_E$$

$$B_L = \underline{908.25\ LB} \longleftarrow$$

$$B_A = A,\ A = .366\ IN^2$$

$$B_A = \underline{.366\ IN^2} \longleftarrow$$

$$B_S = \frac{B_L}{B_A}$$

$$= \frac{908.25\ LB}{.366\ IN^2}$$

$$B_S = \underline{2482\ LBS/IN^2} \longleftarrow$$

$$\text{EXISTING SF} = \frac{\sigma_{YB}}{B_S}$$

$$= \frac{56{,}000\ LBS/IN^2}{2482\ LBS/IN^2}$$

$$SF = \underline{\underline{22.56}} \longleftarrow$$

$B_L = T_L w / P_H$

$B_L = \underline{3764.3 \text{ LB}}$

$B_A = A \quad A = .366 \text{ IN}^2$

$B_A = \underline{.366 \text{ IN}^2}$

$$B_S = \frac{B_L}{B_A}$$

$$= \frac{3764.3 \text{ LB}}{.366 \text{ IN}^2}$$

$B_S = \underline{10{,}285 \text{ LBS/IN}^2}$

$$\text{EXISTING SF} = \frac{\sigma_{YB}}{B_S}$$

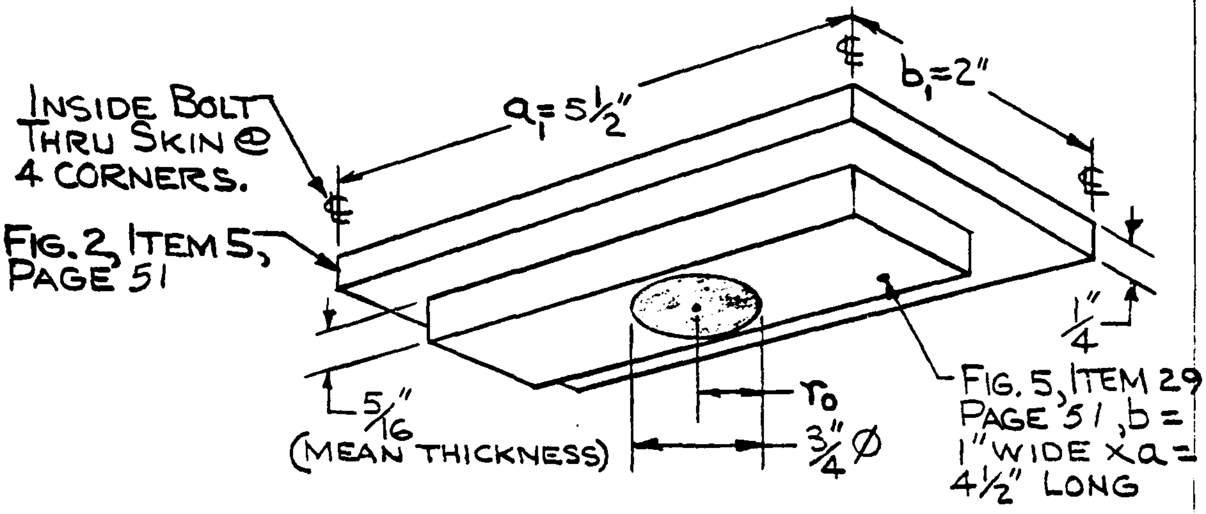
$$= \frac{56{,}000 \text{ LBS/IN}^2}{10{,}285 \text{ LBS/IN}^2}$$

$SF = \underline{\underline{5.44}}$

5.0 LOCKOUT BAR, DETENT

MATERIAL: SEE TABLE 8.1, ITEMS 1 & 5, PAGE 46

<u>SOLVING FOR DEFLECTION (Y)</u>



NOTE: CONSIDER ALL EDGES SUPPORTED WITH UNIFORM LOAD OVER SMALL CONCENTRIC CIRCULAR AREA OF RADIUS r_0.

<u>LOCKOUT BAR</u> b = 1" WIDE, a = 4½" LONG, t = $\frac{5}{16}''$ MEAN THICKNESS

$$Y = \frac{0.203\, T_S\, b^2 (m^2-1)}{m^2 E t^3 (1+0.462\alpha^4)}$$ WHERE; $T_S = \frac{T_L}{T_A}$

$$T_S = \frac{T_L}{T_A} \qquad T_L = P_X\left[\frac{\pi}{4}(2.4375)^2 - \frac{\pi}{4}(.750)^2\right]$$

$$= 5000\,[4.6664 - .4418]$$

$$T_L = \underline{21{,}123 \text{ LBS}} \leftarrow$$

$$T_A = \frac{\pi}{4}(.750)^2$$

$$= .7854 \times .5625$$

$$T_A = .442 \text{ IN}^2 \leftarrow$$

$$T_S = \frac{21{,}123 \text{ LBS}}{.442 \text{ IN}^2}$$

$$T_S = \underline{47{,}789 \text{ LBS/IN}^2} \leftarrow$$

b_1 = 2.00 INS

m = 3.846 (STEEL)
= 2.778 (ALUMINUM)

E = 28×10^6 (STEEL)
= 10×10^6 (ALUMINUM)

t = .3125 (LOCKOUT BAR)
= .250 (SKIN, TUBE)

$\alpha = \frac{b}{a} = \frac{1}{4.5} = .222$ (LOCKOUT BAR)

$\frac{b_1}{a_1} = \frac{2}{5.5} = .3636$ (SKIN)

LOCKOUT BAR - DEFLECTION (Y)

$$Y = \frac{0.203(47{,}789)(1.0)^2(3.846^2-1)}{3.846^2(28\times10^6).3125^3(1+0.462\times.222^4)}$$

$$= \frac{0.203\times47{,}789\times13.79}{14.79\times28\times10^6\times0.0305\times1.0011}$$

$$= \frac{133{,}779}{12{,}644{,}553}$$

$Y = \underline{\underline{.01058 \text{ INS}}}$ ← DEFLECTION ON LOCKOUT BAR

TUBE $b_1 = 2''$ WIDE, $a_1 = 5\frac{1}{2}''$ LONG, $t = \frac{1}{4}''$ THICK

$$Y = \frac{0.203\,T_S\,b_1^2(m^2-1)}{m^2\,E\,t^3(1+0.462\alpha^4)} \quad \text{WHERE; } T_S = \frac{T_L}{T_A}$$

$T_S = \frac{T_L}{T_A}$ $T_L = \underline{21{,}123 \text{ LBS}}$ ← (PAGE 32)

$T_A = a \times b$

$= 4.50 \text{ IN.} \times 1.00 \text{ IN.}$

$T_A = \underline{4.50 \text{ IN}^2}$ ←

$$T_S = \frac{21{,}123 \text{ LBS}}{4.50 \text{ IN}^2}$$

$T_S = \underline{4694 \text{ LBS/IN}^2}$ ←

$$Y = \frac{0.203(4694)(2.0)^2(2.778^2-1)}{2.778^2(10\times10^6).250^3(1+0.462\times.3636^4)}$$

$$Y = \frac{0.203\times4694\times4\times6.7173}{7.7173\times10\times10^6\times0.0156\times1.008}$$

$$Y = \frac{25{,}603}{1{,}213{,}530}$$

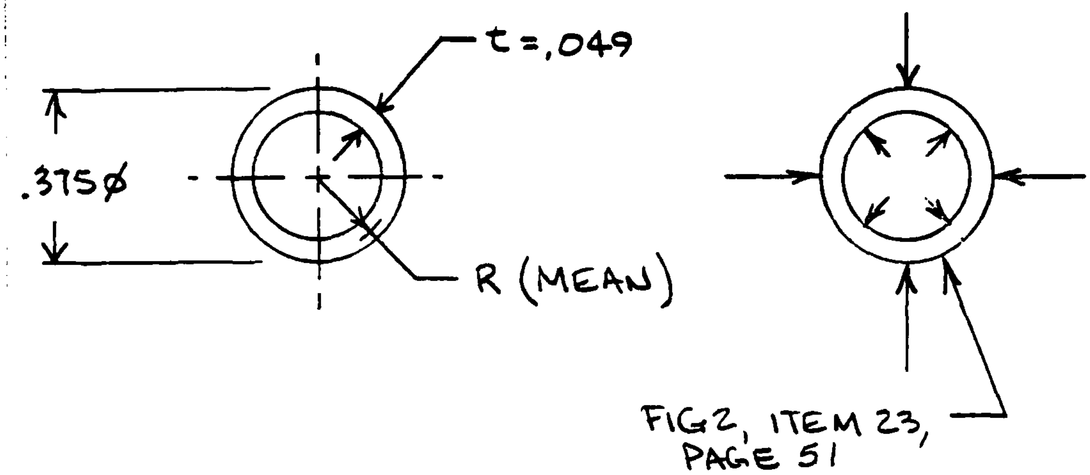
$Y = \underline{\underline{.02109 \text{ INS.}}}$ ← DEFLECTION ON TUBE

NOTE: THE DETENT PIN HAS A TOTAL ENGAGEMENT DEPTH IN THE MOSS OF .50 INCHES. THE MAXIMUM DEFLECTION IS .02109 INCHES, THEREFORE THE DETENT PIN CANNOT BECOME DISENGAGED.

6.0 PLUMBING LINES

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46

SOLVING FOR SF



STRESS FROM INTERNAL PRESSURES

$P_Y = 2000$ LBS/IN^2, $R_{MEAN} = .163$ INS., $t = .049$ INS

$$S_2 = \frac{P_Y R}{t} = \frac{(2000)(.163)}{.049}$$

$$S_2 = \underline{6,653 \text{ LBS/IN}^2}$$

$$\text{EXISTING SF} = \frac{\sigma_Y}{S_2}$$

$$= \frac{30000 \text{ LBS/IN}^2}{6,653 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{4.50}}$$

P_x = 5000 LBS/IN^2, R_{MEAN} = .163 INS., t = .049 INS

$$S_z = \frac{P_x R}{t} = \frac{(5000)(.163)}{.049}$$

S_z = 16,632 LBS/IN^2 ←

EXISTING SF = $\frac{\sigma_{ULT}}{S_z}$

= $\frac{30,000 \text{ LBS/IN}^2}{16,632 \text{ LBS/IN}^2}$

SF = 4.81 ←

STRESS FROM EXTERNAL PRESSURE

$$P' = \frac{t}{R}\left[\frac{\sigma_y}{1+4\left(\frac{\sigma_y}{E}\right)\left(\frac{R}{t}\right)^2}\right]$$

$$P' = \frac{.049}{.163}\left[\frac{30 \times 10^3}{1+4\left(\frac{30\times 10^3}{28 \times 10^6}\right)\left(\frac{.163}{.049}\right)^2}\right]$$

P' = 8610 LBS/IN^2 ←

EXISTING SF = $\frac{P'}{P_z}$

= $\frac{8,610 \text{ LBS/IN}^2}{700 \text{ LBS/IN}^2}$

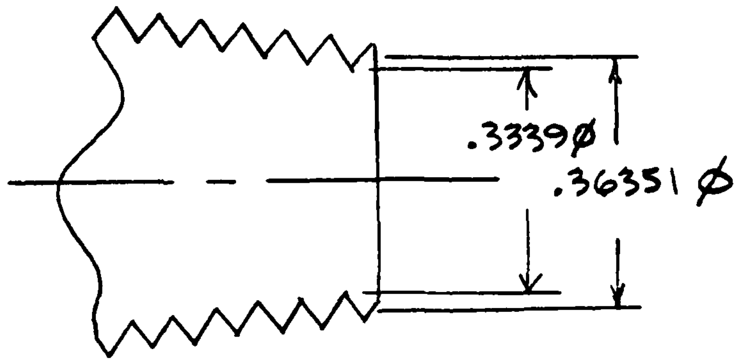
SF = 12.30 ←

7.0 PIPE AND TUBE FITTINGS

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46

SOLVING FOR SF

1/8-27 NPT PLUG:



TENSILE STRESS ON THREADS

$P_D = .36351\phi$, $P = .03704$, $n = 6.75$

$$T_A = \pi P_D\left(\frac{P}{2}\right) n = (3.1416)(.36351)\left(\frac{.03704}{2}\right)6.75$$

$$T_A = \underline{.14276 \text{ in}^2}$$

$$A = \frac{\pi}{4} D^2 = \frac{(3.1416)(.3339)^2}{4}$$

$$A = \underline{.0873 \text{ IN}^2}$$

$$T_L = P_Z(A)$$

$$= (5{,}000 \text{ LBS/IN}^2).0873 \text{ IN}^2$$

$$T_L = \underline{436.5 \text{ LBS}}$$

$$T_S = \frac{T_L}{T_A} = \frac{436.5 \text{ LBS}}{.14276 \text{ IN}^2} = \underline{3{,}056 \text{ LBS/IN}^2}$$

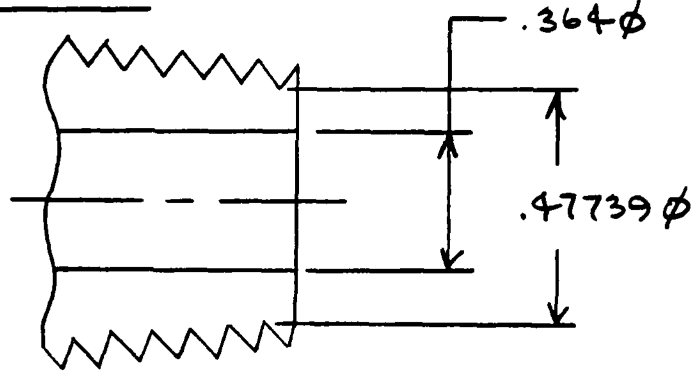
$$SF = \frac{\sigma_S}{T_S} = \frac{15{,}000 \text{ LBS/IN}^2}{3{,}056 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{4.91}}$$

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46

SOLVING FOR SF

1/4 NPT FITTING



$$T_A = \frac{\pi}{4}\left[(.47739)^2 - (.364)^2\right] = \underline{.0749\ IN^2}$$

$$T_L = P_Z(A)$$

$$= 5000\ LBS/IN^2(.1041\ IN^2)$$

$$T_L = \underline{520.5\ LBS}$$

$$A = \frac{\pi}{4}D^2 = \frac{(3.1416)(.364)^2}{4}$$

$$A = \underline{.1041\ IN^2}$$

$$T_S = \frac{T_L}{T_A} = \frac{520.5\ LBS}{.0749\ IN^2} = \underline{6949\ LBS/IN^2}$$

$$SF = \frac{\sigma_{ULT}}{T_S}$$

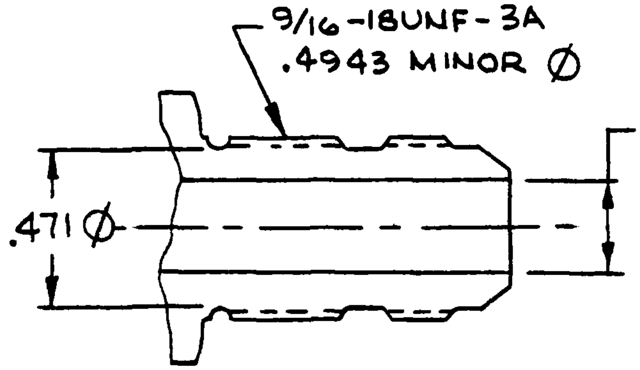
$$SF = \frac{80{,}000\ LBS/IN^2}{6{,}949\ LBS/IN^2}$$

$$SF = \underline{\underline{11.51}}$$

MATERIAL: SEE TABLE 8.1, ITEM 1, PAGE 46

SOLVING FOR SF

FLARED TUBE FITTING FOR 3/8" TUBE IN ACCORDANCE WITH MS33657-6



$$T_A = \frac{\pi}{4}\left[(.471)^2 - (.293)^2\right] = \underline{.1068 \text{ IN}^2}$$

$$T_L = P_z(A)$$

$$= 5{,}000 \text{ LBS/IN}^2 (.067 \text{ IN}^2)$$

$$T_L = \underline{337 \text{ LBS}}$$

$$A = \frac{\pi}{4} D^2 = \frac{3.1416(.293)^2}{4}$$

$$A = \underline{.067 \text{ IN}^2}$$

$$T_S = \frac{T_L}{T_A} = \frac{337 \text{ LBS}}{.1068 \text{ IN}^2} = \underline{3{,}155 \text{ LBS/IN}^2}$$

$$SF = \frac{80{,}000 \text{ LBS/IN}^2}{3{,}155 \text{ LBS/IN}^2}$$

$$SF = \underline{\underline{25.35}}$$

8.0 SUMMARY

THE RESULTS OF THIS ANALYSIS SHOW A CONSERVATIVE MARGIN OF SAFETY IN MOST CASES. IN CERTAIN CASES DEFLECTION WAS CALCULATED ON THE ASSUMPTION THAT IF THE DEFLECTION VALUE WAS VERY SMALL, FAILURE WOULD NOT OCCUR.

MAXIMUM LOAD VALUES SHOWN IN TABLE 8.2, PAGES 47-49, THAT DIFFER FROM THOSE LISTED IN THE INTRODUCTION ARE THE RESULTANTS OF APPLIED DESIGN LOADS.

TABLE 8.1 MECHANICAL PROPERTIES

ITEM NO.	MATERIAL OR DESCRIPTION	MATERIAL SPEC NO.	ULTIMATE TENSILE (PSI)	YIELD (PSI)	SHEAR (PSI)	BEARING ULTIMATE (PSI)	BEARING YIELD (PSI)	MODULUS OF ELASTICITY (PSI x 10^6)
1	300 SERIES CRES	QQ-S-763	80,000	30,000	15,000			28
2	17-4 PH CRES, COND II	MIL-C-24111	155,000	145,000	72,500			28
3	CRES (1/4-28) BOLT, MACH.	AMS5708	175,000	115,000	57,500			28
4	CRES SCREW, FLAT HEAD, 100°	NAS1597	140,000	91,000	49,000			28
5	6061-T6 AL ALY, EXTRUDED	QQ-A-200/8	38,000	35,000	17,500	80,000	56,000	10
6	CRES (3/8-24) BOLT, MACH.	AMS5708	175,000	115,000	57,500			28

8.2 DATA SUMMARY TABLE

PART DESCRIPTION	FIG. NO.	ITEM NO.	MATERIAL	FAILURE MODE	MAXIMUM LOAD	SAFETY FACTOR
TUBE	2	5	6061-T6	COLUMN COMPRESSION	25,000 LB	16.22
CYLINDER	3	1	304 CRES	HOOP TENSION HOOP TENSION HOOP COMP. TENSION	5,000 PSI 2,000 PSI 700 PSI 5,000 PSI	2.74 2.57 6.41 3.84
CYLINDER HEADS	3	3&4	304 CRES	THD SHEAR TENSION TENSION	5,000 PSI 5,000 PSI 2,000 PSI	2.49 3.55 3.32
TRACTION ROD	3	5	17-4 PH CRES	THD SHEAR TENSION	6,032 LB 6,032 LB	4.44 1.97
PIN ROD END	3	7	17-4 PH CRES	SHEAR	6,032 LB	1.806
ROD END, THREADED	3	6	304 CRES	TENSION	6,032 LB	1.87
CYLINDER CAP	3	4	304 CRES	TENSION	6,032 LB	2.93
JAM NUT	3	16	304 CRES	THD SHEAR	6,032 LB	2.19
BRACKET, CYLINDER	3	10	17-4 PH CRES	BENDING	6,032 LB	1.64

8.2 DATA SUMMARY TABLE CONT.

PART DESCRIPTION	FIG. NO.	ITEM NO.	MATERIAL	FAILURE MODE	MAXIMUM LOAD	SAFETY FACTOR
SCREWS, MOUNTING, BRACKET	2	11	NAS1597 COND. F	TENSION BEARING	38,166 PSI 9,155 PSI	2.38 6.12
HOUSING, PISTON	4	2	304 CRES	HOOP TENSION HOOP TENSION HOOP COMP.	5,000 PSI 2,000 PSI 700 PSI	3.34 3.13 8.77
FASTENERS, PISTON CLOSURE	4	12	AMS7471	THD SHEAR TENSION	5,000 PSI 5,000 PSI	7.28 6.00
PIN, DETENT	5	3	17-4 PH CRES	SHEAR	25,000 LB	1.28
COVER	5	2	304 CRES	DEFLECTION DEFLECTION	5,000 PSI 2,000 PSI	.00059 INS. .00024 INS
FASTENERS, COVER	5	11	AMS7471	TENSION TENSION	5,000 PSI 2,000 PSI	2.61 4.28
HOUSING	5	1	304 CRES	HOOP TENSION HOOP TENSION HOOP COMP. SHEAR	5,000 PSI 2,000 PSI 700 PSI 25,000 LB	4.57 4.29 9.76 1.89

8.2 DATA SUMMARY TABLE CONT.

PART DESCRIPTION	FIG. NO.	ITEM NO.	MATERIAL	FAILURE MODE	MAXIMUM LOAD	SAFETY FACTOR
FASTENERS MOUNTING	2	11	NAS 1597 COND F	TENSION TENSION BEARING BEARING	6,032 LB 25,000 LB 5,000 LB 25,000 LB	8.80 2.12 22.56 5.44
LOCKOUT BAR	5	4	17-4 PH CRES	DEFLECTION	5,000 PSI	.01058 IN.
TUBE, EXTERNAL	2	5	6061-T6 AL ALY	DEFLECTION	5,000 PSI	.02109 IN.
PLUMBING LINES	2	23	304 CRES	HOOP TENSION HOOP TENSION HOOP COMP.	5,000 PSI 2,000 PSI 700 PSI	4.81 4.50 12.30
PLUG, PIPE (1/8 NPT)	5	10	316 CRES	THD SHEAR	5,000 PSI	4.91
FITTING PIPE (1/4 NPT)	2	17	316 CRES	TENSION	5,000 PSI	11.51
FITTING TUBE (3/8 TUBE)	2	-	304 CRES	TENSION	5,000 PSI	25.35

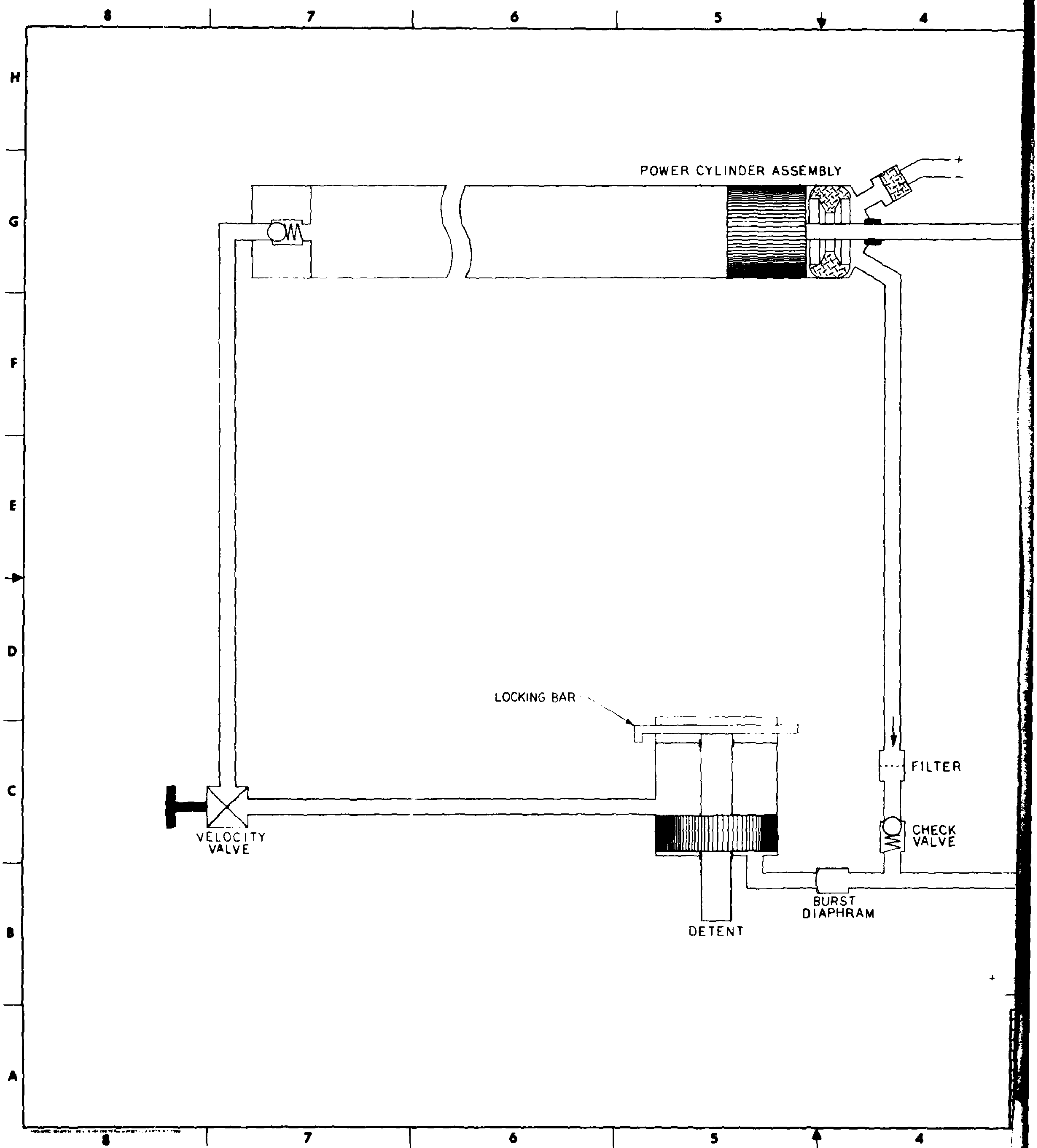
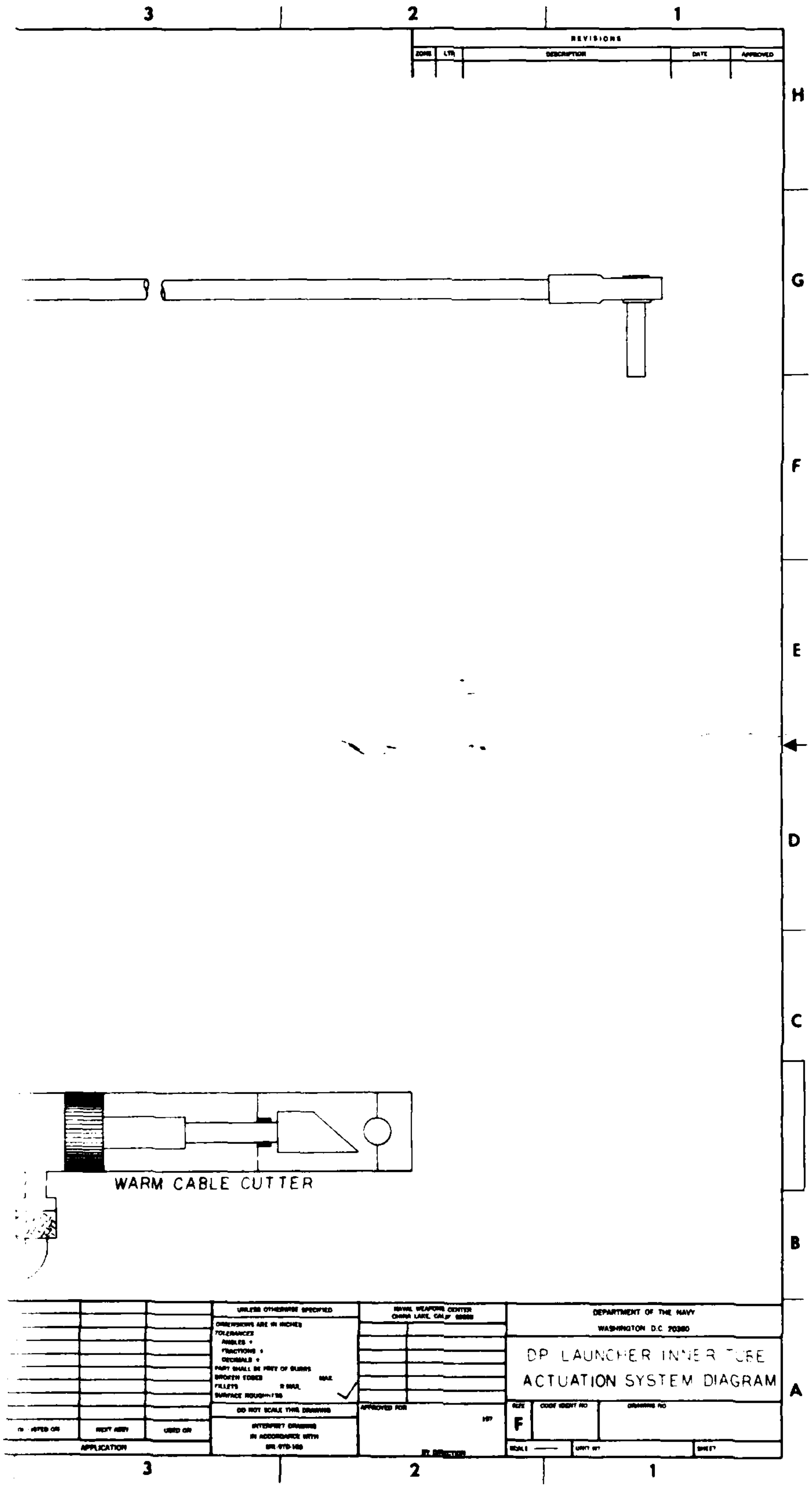

POWER CYLINDER ASSEMBLY
+
-
LOCKING BAR
FILTER
CHECK VALVE
VELOCITY VALVE
BURST DIAPHRAM
DETENT
8
7
6
5
4
H
G
F
E
D
C
B
A

FIGURE 1.


3
2
1
REVISIONS
ZONE
LTR
DESCRIPTION
DATE
APPROVED
H
G
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D
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B
A
WARM CABLE CUTTER
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
FRACTIONS ±
DECIMALS ±
PART SHALL BE FREE OF BURRS
BROKEN EDGES
FILLETS
SURFACE ROUGHNESS
DO NOT SCALE THIS DRAWING
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IN ACCORDANCE WITH
NAVAL WEAPONS CENTER
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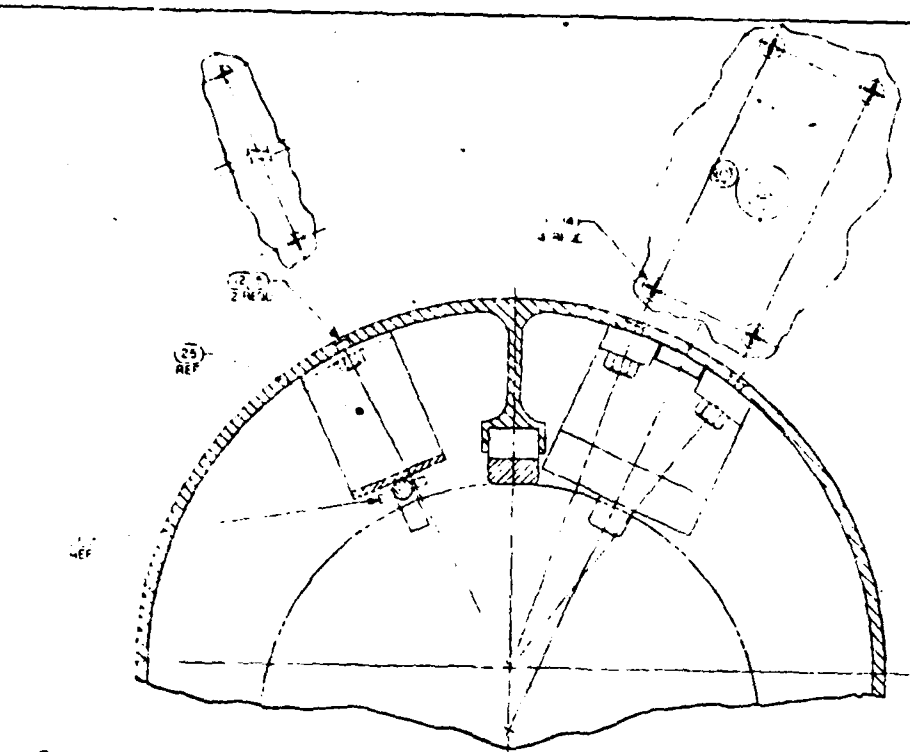
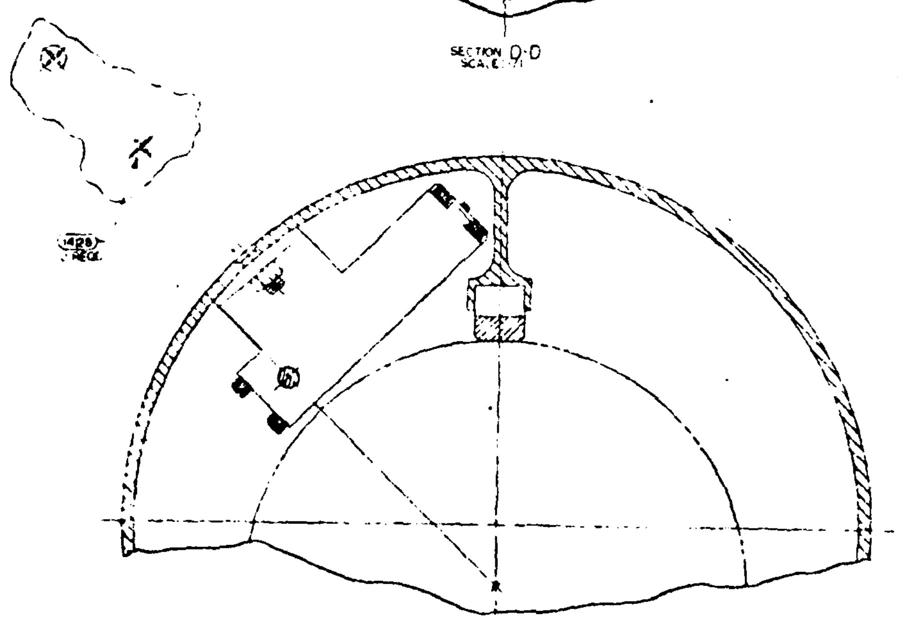
APPROVED FOR
BY DIRECTION
APPLICATION
USED ON
DEPARTMENT OF THE NAVY
WASHINGTON D.C. 20360
DP LAUNCHER INNER TUBE
ACTUATION SYSTEM DIAGRAM
SIZE
F
CODE IDENT NO
DRAWING NO
SCALE
SHEET



SECTION D-D
SCALE 1/1



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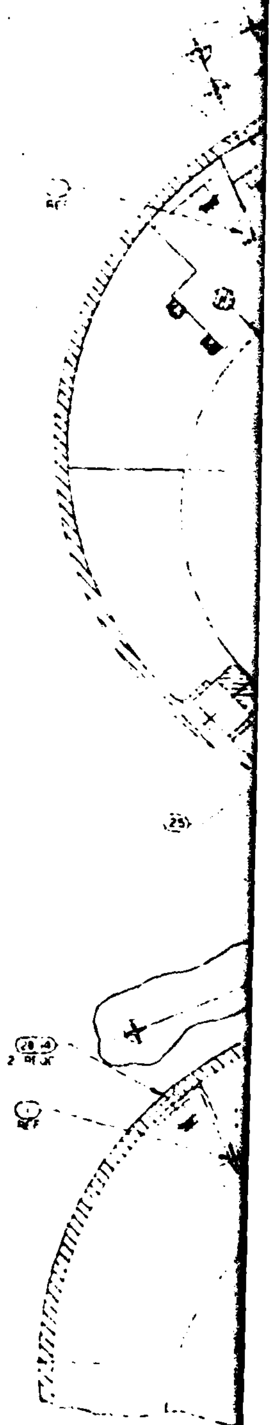
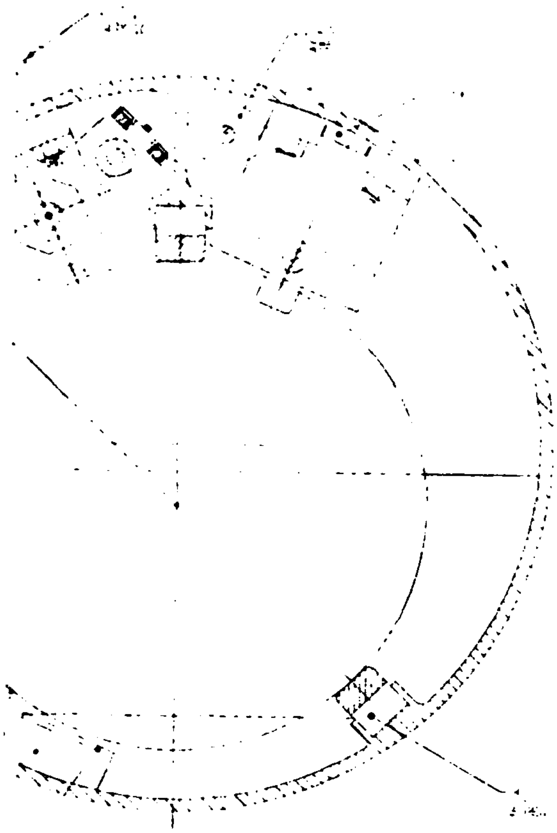
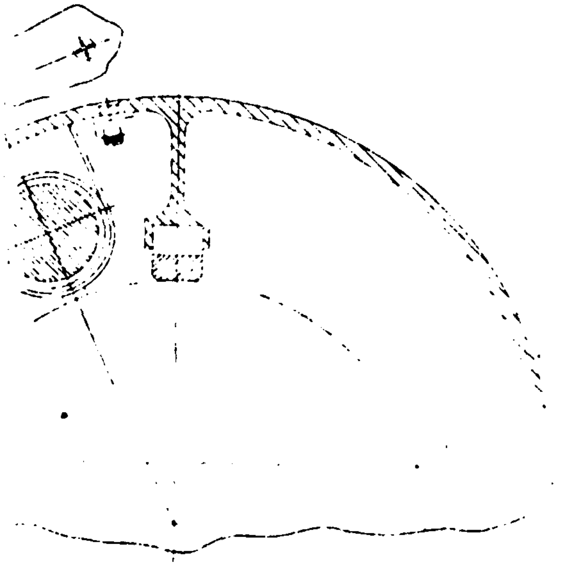
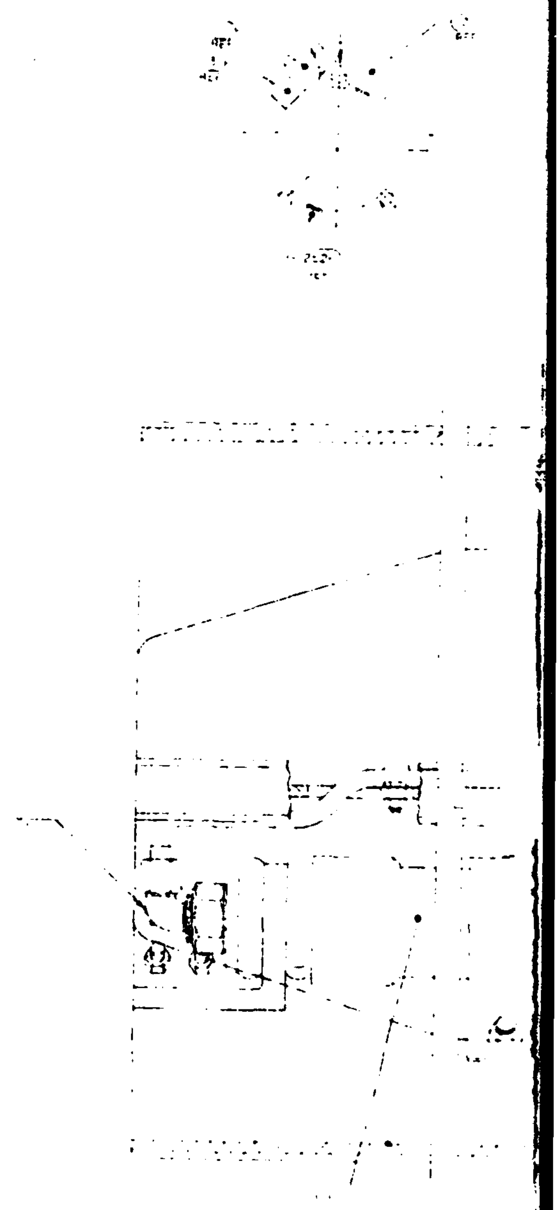




SECTION B B





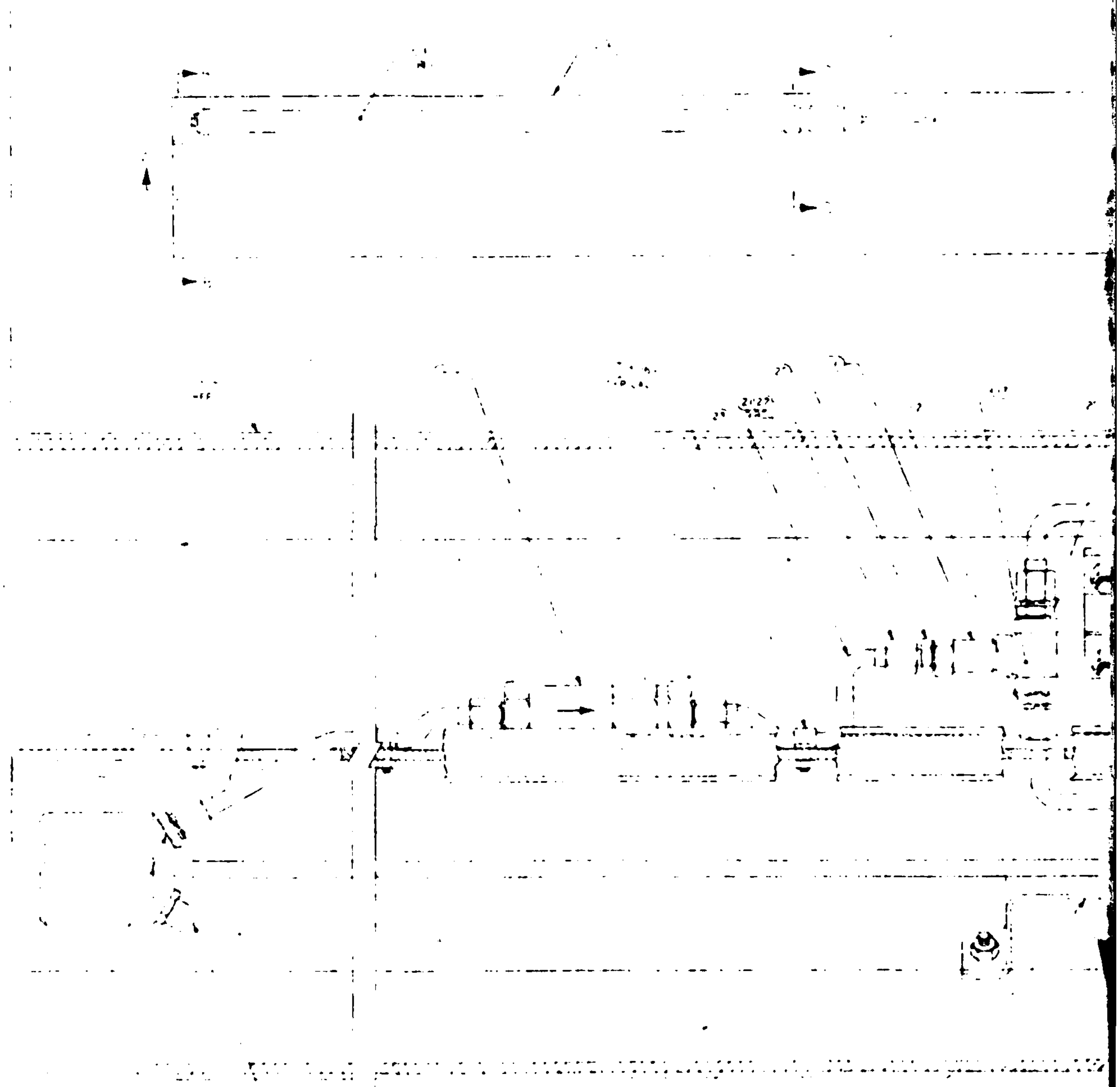
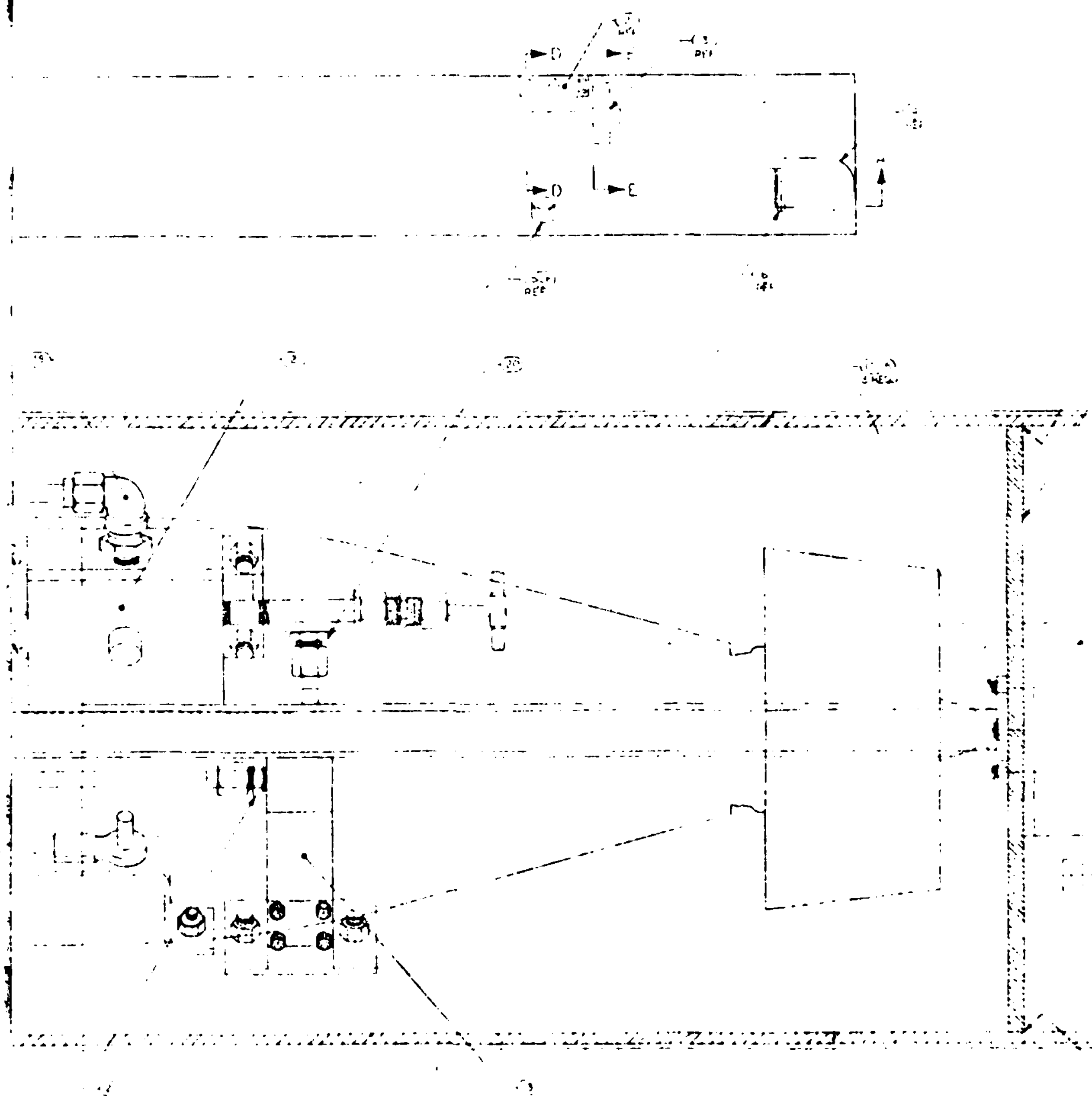
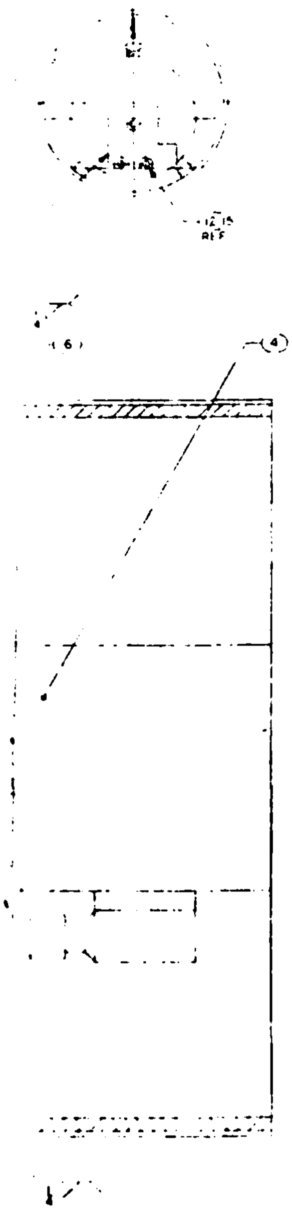


FIGURE 2.





29	1		[illegible]	[illegible] BAR			
28	4		NAS1100-414	SCREW	1/4 28UNF		
27	1			SUPPORT ROD			
26	1			PAD RUBBER			
25	1			FOOT			
24	1			GENERATOR, GAS			
23	AR		3/8 OD .049 WALL	TUBE STAINLESS			
22	10		6BTX SS	NUT	PARKER		
21	10		6TX SS	SLEEVE	PARKER		
20	5		6FBTX SS	CONNECTOR	PARKER		
19	1		6C6TX SS	ELBOW	PARKER		
18	1		6DBTX SS	ELBOW	PARKER		
17	1		1/4 OD 065 SS	TEE	PARKER		
16	AR			NUT	1/4 32 UNF		
15	9			NUT	1/4 28 UNF		
14	12			NUT	1/4 28 UNF		
13	AR			SCREW	10 32 UNF		
12	5		NAS1100 414	SCREW	1/4 28 UNF		
11	8		NAS1100 4T10	SCREW	1/4 28 UNF		
10	AR		MS21919DG	CLAMP CUSHIONED			
9	1		P800 2PM	VALVE, CHECK	CIRCLE SEAL		
8	1		4342	FILTER	MICROPOROUS		
7	3			LAND SUPPORT			
6	1			PLATE			
5	1			HOUSING TUBE			
4	1			METER, VELOCITY			
3	1			CUTTER ASSY			
2	1			RETURN ASSY			
1	1			PLUNGER ASSY			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PARTS LIST

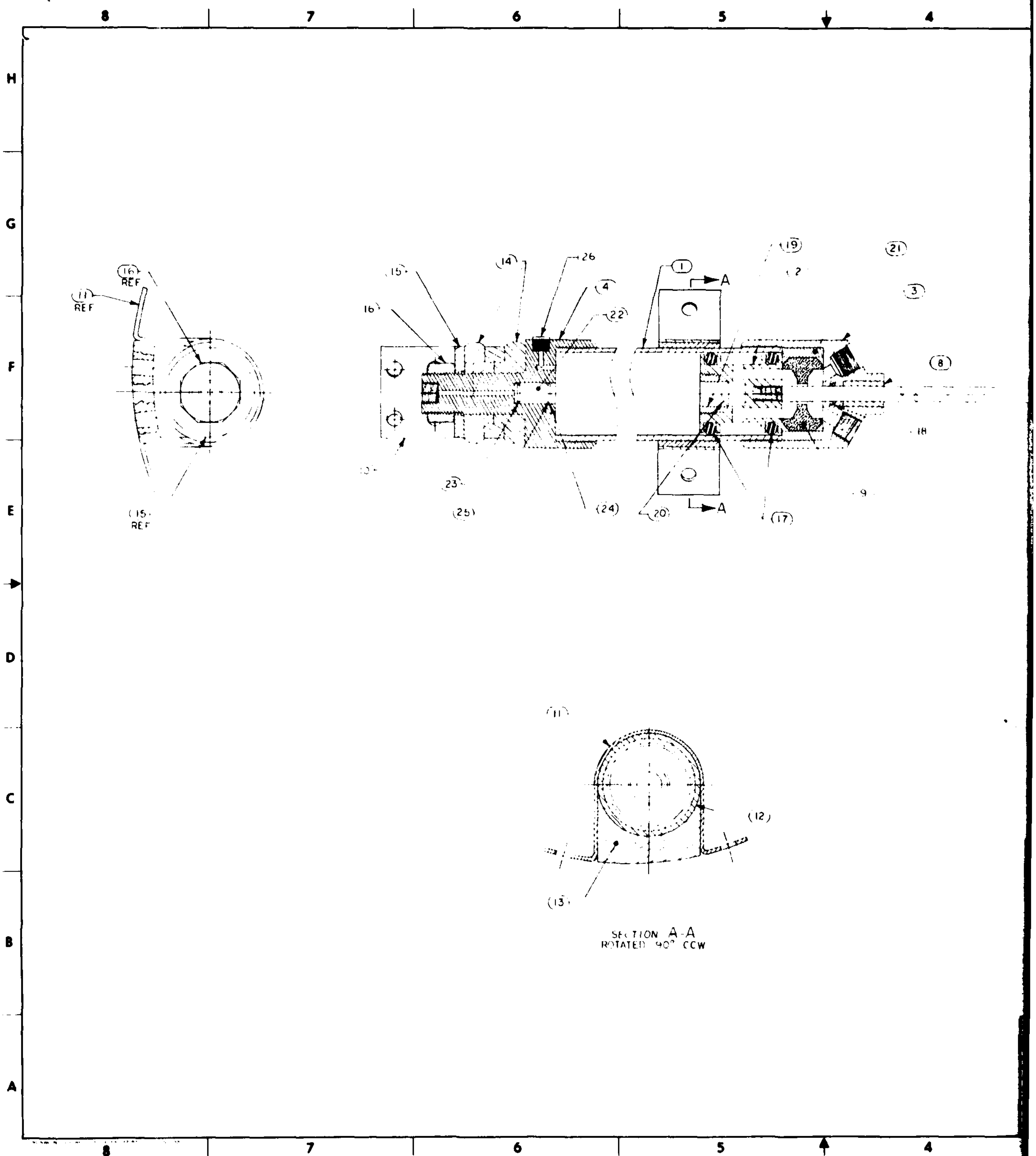
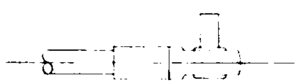


FIGURE 3.

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED



ITEM NO	QTY REQD	CODE IDENT	PART NO OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	NOTE	ZONE
26	1		1/8 HHP-SS	PLUG	PARKER		
25	1			WASHER			
24	1		MS16625-4050	RETAINER			
23	1			O RING			
22	1		C2949S-4Q	VALVE, CHECK	CIRCLE SEAL		
21	1			SLEEVE, PROPELLANT			
20	1			DISC, RUPTURE			
19	1			PLUG			
18	1			O-RING			
17	2			O-RING			
16	1			NUT			
15	1			WASHER			
14	2			BUSHING			
13	1			CUSHION			
12	AR			SLEEVE, RUBBER			
11	1			CLAMP			
10	1			BLACKET			
9	1			GRAIN, PROPELLANT			
8	1			BEARING			
7	1		3750 DIA X 1 125 LONG	PIN			
6	1		2 DREF 6	END, ROD	SOUTHWEST PRODUCTS CO		
5	1			ROD			
4	1			CAP			
3	1			HEAD			
2	1			PISTON			
1	1			CYLINDER			

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
FRACTIONS ±
DECIMALS ±
PART SHALL BE FREE OF BURRS
BROKEN EDGES MAX
FILLETS R MAX
SURFACE ROUGHNESS
DO NOT SCALE THIS DRAWING
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SCALE 1/1 | UNIT WT | SHEET

APPLICATION: NEXT ASSY | USED ON

Sheet 1 of 2

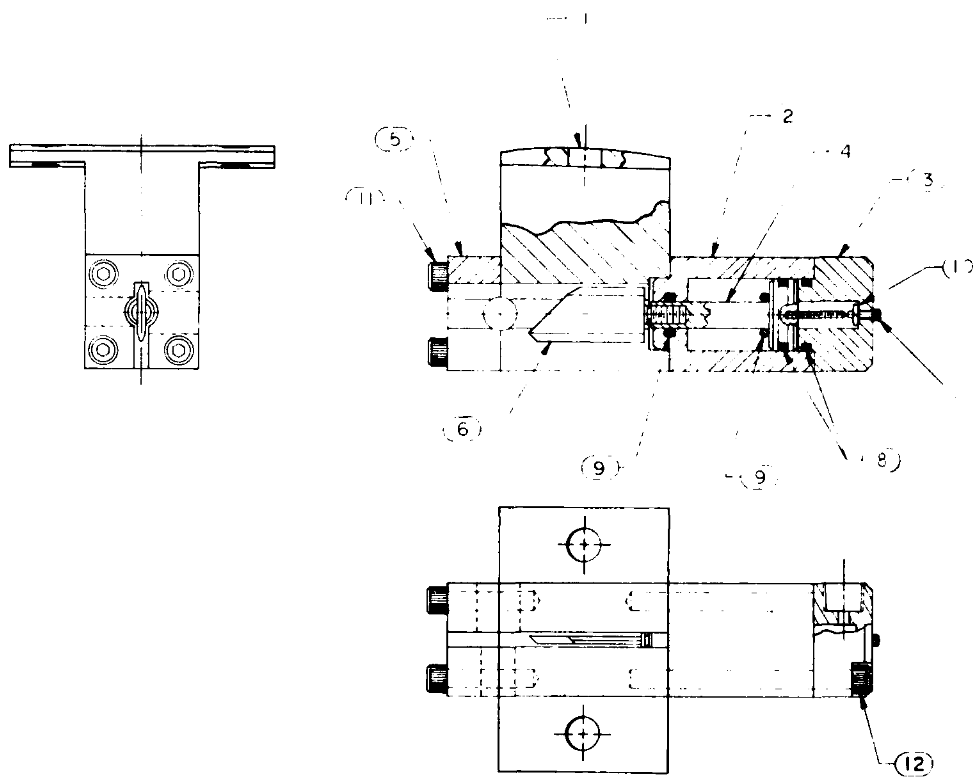
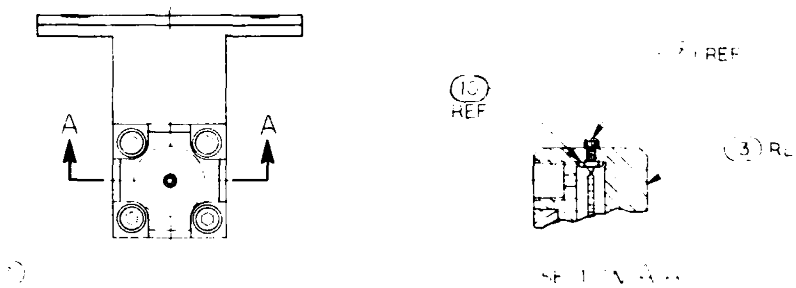


FIGURE 4.

61

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED



ITEM NO	QTY REQD	CODE IDENT	PART NO OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	NOTE	ZONE
12	4		MS9706-35	SCREW	1/4-28 UNF		
11	4		MS16996-24	SCREW	1/4-28 UNF		
10	1		MS35649-244	NUT	4-40 UNC		
9	2			O-RING			
8	2			O-RING			
7	1			BREAKAWAY SCREW	4-40 UNC		
6	1		X3167818	KNIFE			
5	1			END BLOCK			
4	1			PISTON			
3	1			PISTON CLOSURE			
2	1			PISTON HOUSING			
1	1			MOUNTING BLOCK			

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
FRACTIONS ±
DECIMALS ±
PART SHALL BE FREE OF BURRS
BROKEN EDGES MAX
FILLETS R MAX
SURFACE ROUGHNESS

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WASHINGTON, D.C. 20360

DP WARM CABLE CUTTER ASSY

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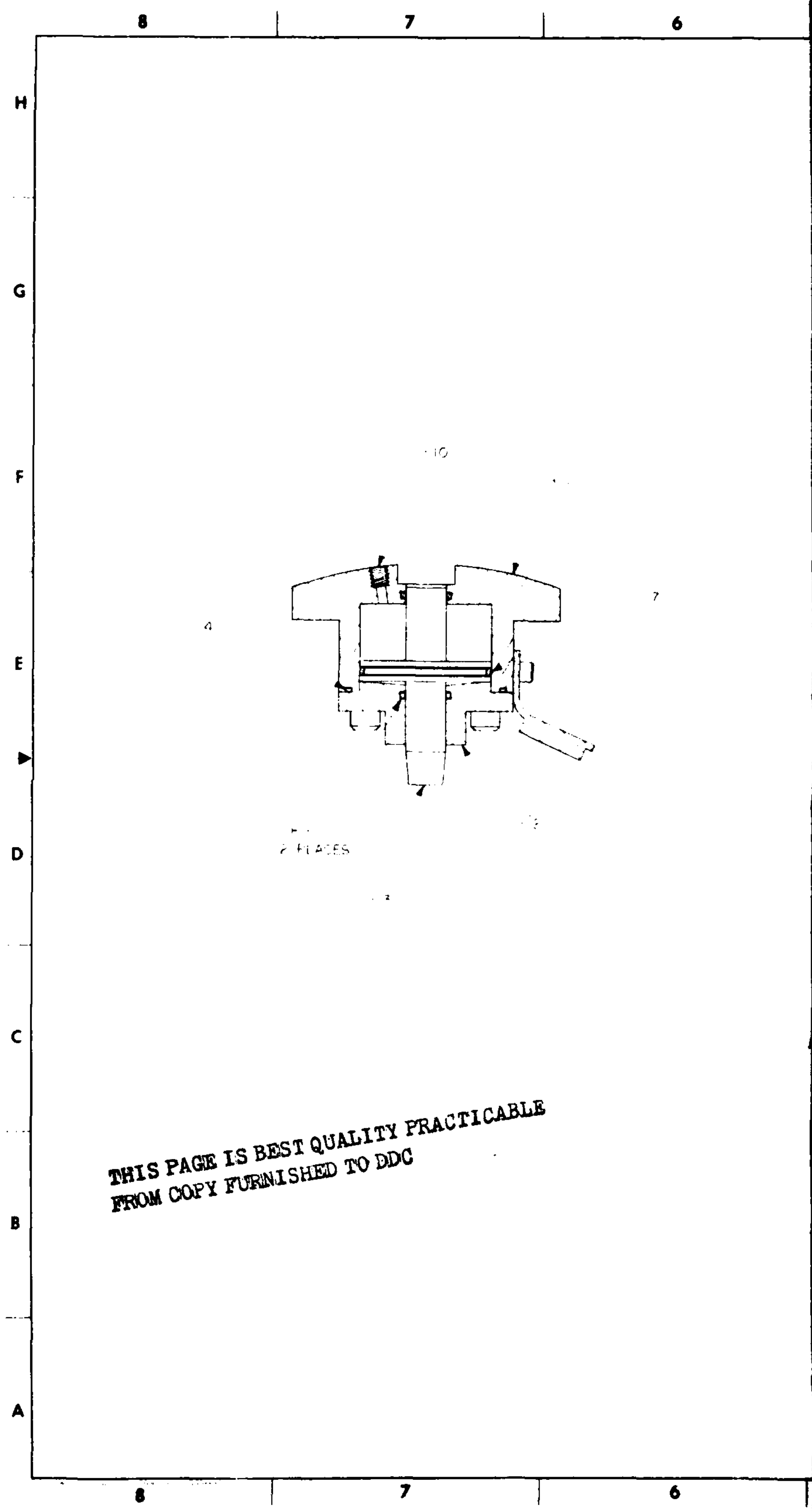
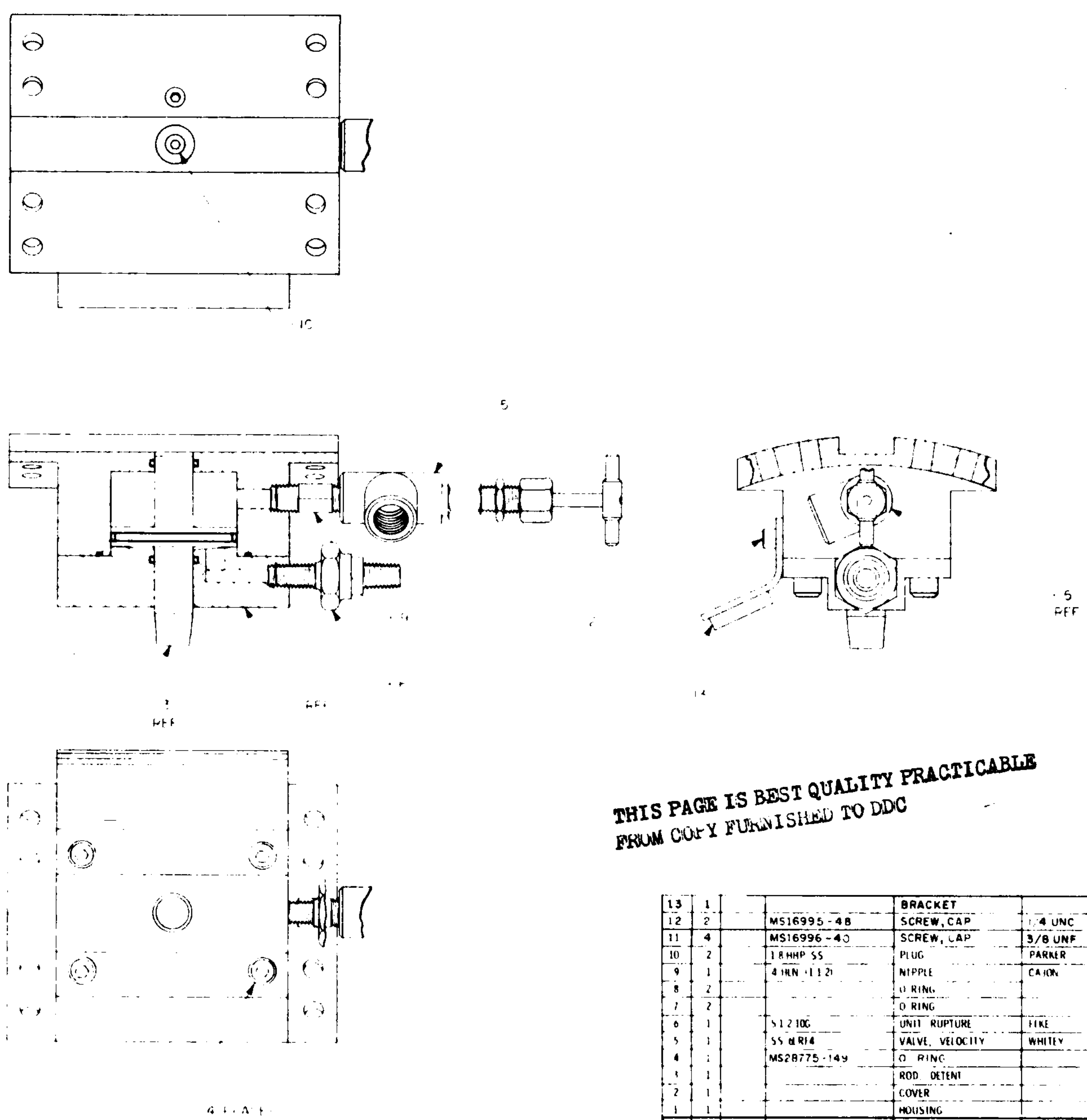
SCALE 1/1 | UNIT WT. | SHEET

NEXT ASSY | USED ON
APPLICATION





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ITEM NO	QTY REQD	CODE IDENT	PART NO OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	NOTE	UNIT
13	1			BRACKET			
12	2		MS16995-48	SCREW, CAP	1/4 UNC		
11	4		MS16996-40	SCREW, CAP	3/8 UNF		
10	2		1 8 HHP SS	PLUG	PARKER		
9	1		4 HLN 1 1 2	NIPPLE	CAJON		
8	2			O RING			
7	2			O RING			
6	1		S 1 2 10G	UNIT RUPTURE	FIKE		
5	1		SS 4 RF4	VALVE, VELOCITY	WHITEY		
4	1		MS28775-149	O RING			
3	1			ROD, DETENT			
2	1			COVER			
1	1			HOUSING			

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WASHINGTON D.C. 20360

DETENT

F

FIGURE 5.